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ENGINES FOR ELECTRIC LIGHTING, BERLIN.

BEFORE entering upon a description of the 1,000 I. H. P. engines built for the central stations of the Allgemeine Electricitats Gesellschaft, of Berlin, by the Societe Anonyme Van den Kerchove, of Ghent, Belgium, it may not be out of place to inform our readers that electric lighting has taken such an extension in Berlin that the Electric Lighting Company, the "Allgemeine Electricitats-Gesellschaft," was obliged, last year, in order to respond to the numerous demands of its subscribers, to decide upon the erection of three new central stations of the first importance. The first, Fig. 1, was put up in the Spandauerstrasse, the second, Fig. 2, in the Mauerstrasse, and the third, Fig. 3, at the Schiffbauerdam. These three stations, of which we shall only give a summary description, will, when they are completely finished, comprise, the first four engines of 1,000 I. H. P.; the second, three engines of 1,000 I. H. P. and four of 300 I. H. P.; and the third, five engines of 1,000 I. H. P. and two of 300 I. H. P.; making altogether an aggregate of more than 13,000 I. H. P. Although erected in the center of Berlin, where works of this kind are only carried out at enormous cost, these installations are really magnificent, and leave nothing to be desired in any respect. The annexed diagrams, Figs. 1, 2, and 3, show the general arrangement of each.

The engine and boiler rooms are superb. Everything is foreseen, nothing being left to chance; and although space is carefully economized, there is no cramping. Apart from the magnificent installations which we have at Deptford, nothing so grand or so complete has been put up until now in the way of central stations for electric lighting. All those concerned in installations of the kind would do well to visit the central station at Berlin if they have an occasion of so doing.

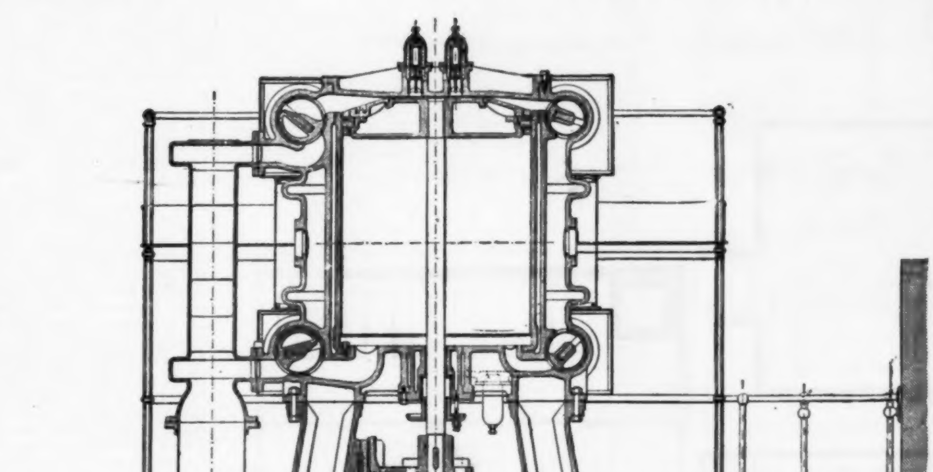
The 1,000 I. H. P. engines which the firm of Van den Kerchove is now building for these new installations are vertical Corliss compound condensing engines, with cranks at 90 deg., of the marine type. The cylinders are supported upon massive columns, well braced together, and making an *ensemble* much more rigid than is generally the case in this kind of engine, where a long stroke of piston is used. The double crank shaft, which is more than 35 ft. in length, is built up in sections with separate cranks and crank pins, and put together in a most ingenious manner. This is really a masterpiece of workmanship with regard to the accuracy with which it is executed. The great difficulty here lies in obtaining a perfect center line through the various sections during their construction, and in maintaining this when erected and working, notwithstanding the unequal wear of the brasses in which it runs. This the builder has succeeded in realizing in the most simple and efficient manner, owing to the great accuracy he brings to bear upon the execution of his work.

Contrary to the practice hitherto followed in engines by the same builder, such as those which we published in our issue of September 6 last year, the new 1,000 I. H. P. drive two dynamos, these being placed one on either end of the engine. This arrangement allows of a better distribution of the stresses, makes the engine more accessible and renders the taking to pieces more easy, and finally gives the great advantage of allowing the engine to be run with only half the power, in case of accident to either of the dynamos. The principal dimensions of these engines are:

Diameter of low pressure cylinder, 52 in.; Diameter of high pressure cylinder, 29 in.; Stroke of piston, 4 ft. 9 in.; Diameter of shaft in bearings, 13½ in.; Length of outer bearing, 20 in.; Length of inner bearing, 17 in.; Diameter of crank pin, 12 in.; Length of crank pin, 11½ in.; Diameter of piston rods, 5½ in.

The cylinders are steam jacketed and fitted with separate liners. The receiver space is continued round the jacket of the low pressure cylinder. Each cylinder has four Corliss valves with variable automatic cut-off, controlled by the governor, which is fitted with a new application introduced by Mr. Corliss in order to minimize the variations of speed in the engine when running under very different loads, which is not without its value in engines destined for electric lighting purposes. These engines, which were sold to develop 1,000 E. H. P. with a pressure of seven atmospheres in the small cylinder, are so largely proportioned that they can easily develop 1,500 I. H. P. with the same initial pressure. Several of these engines are in course of erection at the different stations of which we have spoken.

The first of them was started at the Spandauerstrasse station on the 20th of November last, and has been running uninterruptedly every day since. All who have had the advantage of seeing this engine working are loud in the praise of its quite exceptional beauty; some of its admirers assure us that this important engine runs so very smoothly that one would think one had to do with an engine of only 20 horse power. All this speaks in high praise of a firm whose great success we foretold some years ago, a success well merited, too, by the exceptional care it bestows upon its work, which has classed for some time past among that of the best known firms.—*The Engineer.*



1,000 H. P. ELECTRIC LIGHT ENGINES.

RESISTANCE OF HYDROGEN AND OTHER GASES.*

By E. VILLARI.

AN arc light between carbon points of 1 cm. diameter is well known to be shorter in a horizontal than in a vertical direction; and the arc is somewhat longer in a vertical position with an ascending current than with a descending one, doubtless owing to the greater heat of the anode, which must become more strongly heated when it is uppermost.

Arc lights were formed in glass bulbs which were filled with dry gases. The carbon electrodes were superimposed in a vertical position, and were then drawn apart from each other until the arc light disappeared.

The arc was found to be far shorter in hydrogen than in carbonic acid, and in the latter, again, shorter than in air; the ratio of the lengths was about 3·9 : 7·4 : 8·5. In nitrogen, with an ascending current, it is about seven times as long as in hydrogen, and with a descending current it is 25·7 times as long. With decrease of pressure the arc lengthens in nitrogen, hydrogen, and coal gas; in the two latter, however, it never attains the same length as that of the arc in air. With platinum electrodes the lengths of the arcs in carbonic acid, nitrogen, coal gas, and hydrogen at ordinary pressures were in about the ratio 16 : 19 : 4·6 : 2·8.

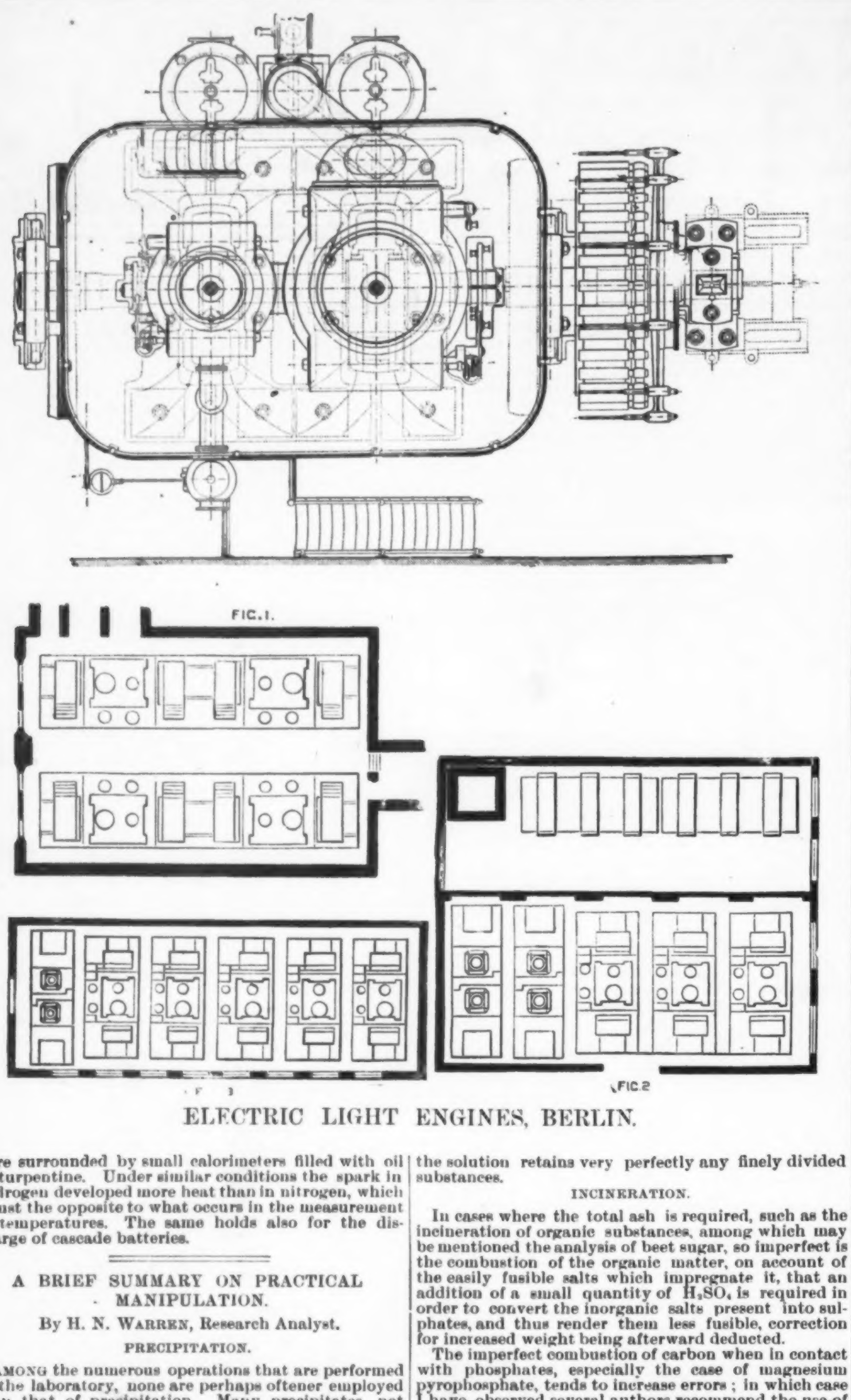
The production of heat at the electrodes was determined for various gases with sparks from a Ruhmkorff's inductorium. The electrodes were thermo-elements of iron and German silver. The heating was investigated in two globes filled with various gases, in which the distance between the electrodes was almost identical. The heating of the negative electrode was greater than with the positive; the difference of the heating effect seemed also to be greater in nitrogen than in hydrogen.

A globe filled with hydrogen or with nitrogen was next used, through which the induction spark was passed, and the strength of the current measured by a well insulated galvanometer. The induced discharge was more enfeebled by a layer of hydrogen than by an equally thick one of nitrogen. Moreover, equally thick layers of hydrogen and nitrogen enfeebled the discharge as much as columns of water of 99 and 59 mm. respectively. In order to diminish the induction current by the same amount, the length of the spark in hydrogen was 33 mm., in nitrogen 48 mm., and in carbonic acid greater than 49 mm. Hence the resistances were in the order—carbonic acid, nitrogen, hydrogen. The heating of the electrodes increases with the rarefaction.

The spark was then made to pass over the bulb of a mercurial thermometer in various gases. The temperature increased more strongly in nitrogen than in hydrogen, both for the induction spark and for the spark for the battery discharge. The heating with both was much smaller in hydrogen than in nitrogen, so that in passing through nitrogen the discharge has a much smaller electro-magnetic and thermal intensity than in passing through nitrogen. By substituting for the spark other resistances the same result was obtained. A layer of nitrogen 47·6 mm. in length enfeebles the intensity of the induced current to the same extent as a layer of hydrogen 36·95 mm. in length; and a layer of carbonic acid 49 mm. in length as much as a spark 33 mm. in length with the battery discharge. The negative electrode is almost as strongly heated with the discharge in hydrogen as in nitrogen. With the discharge of the condenser it is more heated in nitrogen.

The spark was finally produced in glass tubes which

* From the *Philosophical Magazine.*



ELECTRIC LIGHT ENGINES, BERLIN.

were surrounded by small calorimeters filled with oil of turpentine. Under similar conditions the spark in hydrogen developed more heat than in nitrogen, which is just the opposite to what occurs in the measurement of temperatures. The same holds also for the discharge of cascade batteries.

A BRIEF SUMMARY ON PRACTICAL MANIPULATION.

By H. N. WARREN, Research Analyst.

PRECIPITATION.

AMONG the numerous operations that are performed in the laboratory, none are perhaps oftener employed than that of precipitation. Many precipitates, not among the least of which noted for tedious and imperfect filtration may be mentioned those of barium sulphate and calcium oxalate, when recently precipitated, pass in considerable quantity through the pores of the paper. This may naturally be considerably retarded by employing both solutions at the boiling point. But even then considerable risks are entertained, combined with a grievous waste of time. The addition of starch paste has been recommended by several experts, but the same investigators omit to state what percentage of sulphide they obtain after ignition. I may mention, as an improvement, the following method: Employ both the reagent and the solution containing the sulphate at an elevated temperature; at the same time introduce a few drops of ethereal solution of pyroxilin and mix well with the precipitate by stirring; the pyroxilin is at once set free, and mixing intimately with the precipitate, allows of an immediate filtration. The separation of iron from manganese by means of sodium acetate is well known to be among the bulkiest precipitates obtainable for practical purposes; yet, if at the boiling temperature there be added to the precipitate finely powdered glass, it at once mechanically subsides, and, if dexterously performed, may be filtered and washed with impunity. As a third instance may be mentioned the effectual separation of precipitates occasioned during the manufacture of the pharmaceutical preparations, one of the most obstinate being the *Tinctura rhei* of the British pharmacopœia.

A sample of this description which was lately presented to my notice has been, by the manufacturers, several times ineffectually passed through the varil of commercial filters. The sample referred to, which was, when received, of a deep cloudy slate color, due to suspended insoluble matter, was, after a short digestion with a small quantity of egg albumen, entirely freed from coherent matter by ordinary filtration. I may also mention that paper pulp distributed throughout the solution retains very perfectly any finely divided substances.

INCINERATION.

In cases where the total ash is required, such as the incineration of organic substances, among which may be mentioned the analysis of beet sugar, so imperfect is the combustion of the organic matter, on account of the easily fusible salts which impregnate it, that an addition of a small quantity of H_2SO_4 is required in order to convert the inorganic salts present into sulphates, and thus render them less fusible, correction for increased weight being afterward deducted.

The imperfect combustion of carbon when in contact with phosphates, especially the case of magnesium pyrophosphate, tends to increase errors; in which case I have observed several authors recommend the use of ammonium nitrate as a consumer of the carbon. I have, however, frequently used with success a plug of gun cotton, omitting altogether a filter paper.

PRECIPITATION RETARDED.

Several organic acids or salts of the same are well known to retard the precipitation of metals when in solution. Among the most formidable are the tartrates and oxalates, also the citrates, which are not unfrequently unintentionally formed by the incautious filtration of strongly acid liquors through organic membranes; these may be altogether prevented by the employment of wool glass; they are not, however, by any means the only acids that present a retarding action, one of the most opposing being hydroferrocyanic acid. So powerful is the action of this acid when in solution toward the salts of tin, as not only to render the sulphide of tin unprecipitable, but even to immediately decompose it into the ferrocyanide after its formation.

READING OF DEFINITE QUANTITIES FROM MEASURED FLASKS.

At the moment it may be desirous of denoting the exact capacity of a measured instrument, say, for instance, the reading from a measured flask, it not unfrequently happens that an accumulation of either froth or air bubbles obliterates the dimension. These may be immediately expelled by the addition of one drop of alcohol.

DISINTEGRATION.

The pulverization of many substances, before operating further upon the same, not unfrequently presents one of the most irksome and troublesome undertakings that are to be met with in a laboratory, especially when adopting the general method of pestle and mortar. Quite recently small disintegrators have been supplied for practical purposes; but the present costliness of the article considerably retards their general application. In cases where it is required to reduce to powder, such as, for instance, the pulverization of minerals, several pounds may be quickly reduced to any mesh by the application of a smooth iron plate, replacing for a pestle a large flat-headed hammer, and giving to the same a rotary motion, so as to constantly bring the same particles under its influence.

CASTING AND MOULDING.

After the assay of a metal has been completed, it not unfrequently happens that a sample of the same is required in an elongated form in order to examine its tensile strength or other physical features. A very ready mould, and one which answers the purpose admirably on account of the non-introduction of foreign substances, may be formed by coiling round an ordinary pencil, or other convenient appendage, several thicknesses of writing paper, closing the extremity by means of a cork, and supporting the same by immersing it to the extremity into dry sand, afterward withdrawing the core and pouring into it the intended metal. A very perfect and uniform cast is thus obtained, which may be tested by weighting the same from about every other inch in length. By this means a very good indication will at once be formed whether any liquation has preceded the casting, on account of the inconstancy either of the metal or alloy that has thus been treated. These paper moulds are not intended for metals above the melting point of zinc; for copper, iron, etc., asbestos sheeting should be used in its stead.

COMBUSTION TUBING (HOW TO PRESERVE).

During a tube combustion, employing the ordinary glass tubing in general use for that purpose, direct contact of the contents will oftentimes be observed to cause, either while hot or when cold, a fracture of the glass, and thus prevent further use of the same; a thin strip of asbestos placed next to the glass will in many cases prevent breakage, and thus preserve the same tube for various further operations. Many combustion estimations may be accurately performed in an iron tube.

UNSUSPECTED IMPURITY OF ACIDS.

The impurity of the various commercial acids is generally well known, and the foreign substances most frequently found contaminating them are naturally sought for before employing the purer acids. As a rule, however, nitric acid, excepting small quantities of sulphates and chlorides, is usually supposed to escape contamination. I may, however, mention that I have frequently detected selenium in a so-called pure acid. As the acid was intended for parting gold, on account of the vigorous way in which selenic acid attacks that metal, it might, if it had escaped detection, cause considerable errors. It would be interesting to know to what extent of division the millionth part of a grain of gold would become if subjected to such an impurity.—*Chem. News.*

COMPOSITION OF EIKONOGEN, THE NEW PHOTOGRAPHIC DEVELOPER.

COPY of the English patent: I, Momme Andresen, of 44, Melchiorstrasse, Berlin, in the empire of Germany, chemist, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

My invention relates to the development of photographic pictures by means of diamidonaphthaline $C^{10}H^{6}\left\{\begin{matrix}NH^2\\NH^2\end{matrix}\right.$ amidonaphthol $C^{10}H^{6}\left\{\begin{matrix}OH\\NH^2\end{matrix}\right.$ and dioxynaphthaline $C^{10}H^{6}\left\{\begin{matrix}OH\\OH\end{matrix}\right.$ as well as their sulpho acids:

Diamidonaphthaline monsulphonic acid $C^{10}H^{5}\left\{\begin{matrix}NH^2\\NH^2\\SO^2\,OH\end{matrix}\right.$

Diamidonaphthaline disulphonic acid $C^{10}H^{4}\left\{\begin{matrix}NH^2\\NH^2\\(SO^2\,OH)^2\end{matrix}\right.$

Amidonaphthol monosulphonic acid $C^{10}H^{5}\left\{\begin{matrix}OH\\NH^2\\SO^2\,OH\end{matrix}\right.$

Amidonaphthol disulphonic acid $C^{10}H^{4}\left\{\begin{matrix}OH\\NH^2\\(SO^2\,OH)^2\end{matrix}\right.$

Dioxynaphthaline monosulphonic acid $C^{10}H^{5}\left\{\begin{matrix}(O\,H^2)_2\\SO^2\,OH\end{matrix}\right.$

Dioxynaphthaline disulphonic acid $C^{10}H^{4}\left\{\begin{matrix}OH\\OH\\(SO^2\,OH)^2\end{matrix}\right.$

As is well known in photography, it is the practice to treat the sensitive plates (prepared with chloride, bromide, or iodide of silver, or with two or all of the salts) after exposure with a developing solution, in order to bring to view the image produced on the sensitive plate. The developing solution hitherto employed for this purpose has usually consisted of a solution of oxalate of iron, pyrogallic acid, or hydrochinone.

Now, I have found by experiment that the before-mentioned substances, diamidonaphthaline, amidonaphthol, and dioxynaphthaline, as well as their sulpho acids, are exceptionally suitable for developing photographic pictures produced on the said sensitive plates, and give better results than can be obtained with an alkaline pyrogallol developer, and excel the later by giving the plates a blue-black tint similar to that produced when developing in a bath of oxalate of iron, without in the least coloring the sensitive plate, but enabling the plate to better resist the alkaline action of the bath. I thus obtain the advantages possessed by known developing baths without their disadvantages.

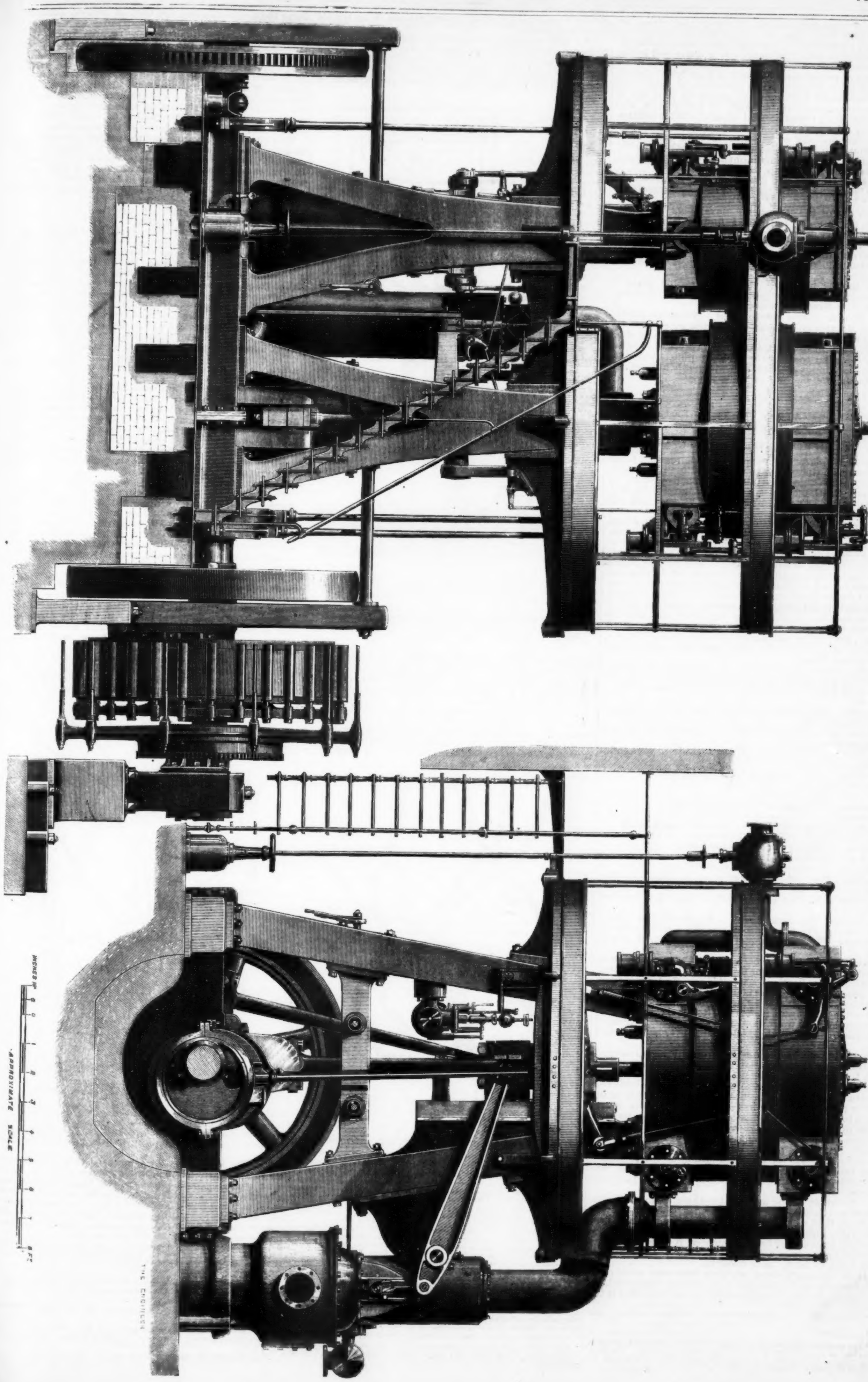
A developing bath prepared with my naphthol developer in which it is intended to immerse the sensitive plate after having been exposed, for the purpose of producing a visible picture, is, for instantaneous photography, advantageously composed of the following ingredients:

Five grammes of the hereinbefore described naphthol developer.

Fifteen grammes of sulphite of soda.

Two hundred and fifty grammes of distilled water.

Five grammes of potash.



ONE THOUSAND HORSE-POWER COMPOUND ENGINES FOR ELECTRIC LIGHTING, BERLIN.

The above proportions can, however, be varied, or one or the other of the ingredients can be substituted by others providing the essential part, namely, the before mentioned naphthol developer is contained in the developing bath.

Instead of potash soda carbonate, soda lye or potash may be used, in which case it is preferable to replace the before mentioned 5 grammes of potash by 20 drops of a concentrated or saturated soda of potash lye, and this is especially recommended when diamidonaphthaline or its sulphonic acids are used. In the same proportion the quantity of sulphite of soda can be advantageously increased when alphanaphthol derivatives (such as amidoalphanaphthol) or their sulpho acids, as mentioned above, are used.

The before mentioned five grammes "naphthol developer" may be used with any of the above combinations.

As any one of the "naphthol developers" is suitable for the present purpose, I find it is not absolutely necessary to restrict myself to the use of only one of the "naphthol developers" for the bath, so that the quantity of "naphthol developer" to be used refers also to mixtures of the above named "naphthol developers."

After having immersed the photographic plate in this bath till the picture becomes completely developed, it is then fixed in the usual way.

The process herein described of developing photographic pictures on coatings of chloride of silver, bromide of silver, or iodide of silver, or of any two or of all three of them in combination, such process consisting in treating such coatings in a developing bath containing diamidonaphthaline, amidonaphthol, or dioxynaphthaline, or their sulpho acids.

THE EXAMINATION OF TEXTILE FIBERS AND FABRICS.*

By H. SCHLICHTER, D.Sc. Nat.

IN the first place, my paper does not pretend to be an account of the constitution of textile fibers. This branch of the subject has already been dealt with by Chevreul, Grothe, Cramer, Schulze, Hugo Muller, Mulder, Schutzenberger, Bourgeois, and others; but this paper is intended to describe methods by which chemists may identify and distinguish various textile fibers, and estimate them quantitatively in textile fabrics. Moreover, the paper is limited to such textile fibers as find practical application in the European manufacture of textile fabrics, among which I do not include paper.

The technical examination of fibers and fabrics has hitherto been dealt with systematically only to a very limited degree, although there exist a number of more or less elaborate monographs, mostly based on microscopical studies, in which may be found at intervals valuable material in the shape of descriptions of reactions, properties, and measurements. Many of these, however, are merely color tests, applicable only to undyed or raw fibers.[1]

Among the authors who may be regarded as having contributed to the literature of this subject are the following, to whose names we append the titles of their works:

Schacht: Die Prufung der im Handel vorkommenden Gewebe, 1853.
Schlesinger: Mikroskopische Untersuchungen der Gespinnstfasern, 1873.
Hohnel: Die Mikroskopie der technisch verwendeten Faserstoffe, 1887.
Kolliker: Mikroskopische Anatomie, 1850.
Kolliker: Gewebelehre, 1852.
Leydig: Histologie, 1857.
Nathusius: Wollhaar des Schafes, 1866.
Wiesner: Technische Mikroskopie, 1867.
Wiesner: Mikroskopische Untersuchungen, 1872.
Wiesner: Rohstoffe des Pflanzenreiches, 1873.
Bolley: Technologie der Spinnfasern.
Bohm: Wollkunde, 1873.
Grothe: Technologie der Gespinnstfasern, 1875.
Grothe: Die Gespinnstfasern aus dem Pflanzenreiche, 1879.
Vetillart: Etudes sur les fibres vegetales textiles, 1876.
Bowman: The Structure of the Cotton Fiber, 1881.
Bowman: The Structure of the Wool Fiber, 1885.
Christy: Ne Commercial Plants and Drugs, No. 6, 1882.

In many of these works we find little or no trace of a systematic treatment of the subject, but here, as well as in other publications not cited, we find notices on the properties of various fibers. When we realize the practical importance of the textile industries of this and other European countries, it is very difficult to understand why up to this time no *general scheme* of analysis in this branch of science has ever been worked out.

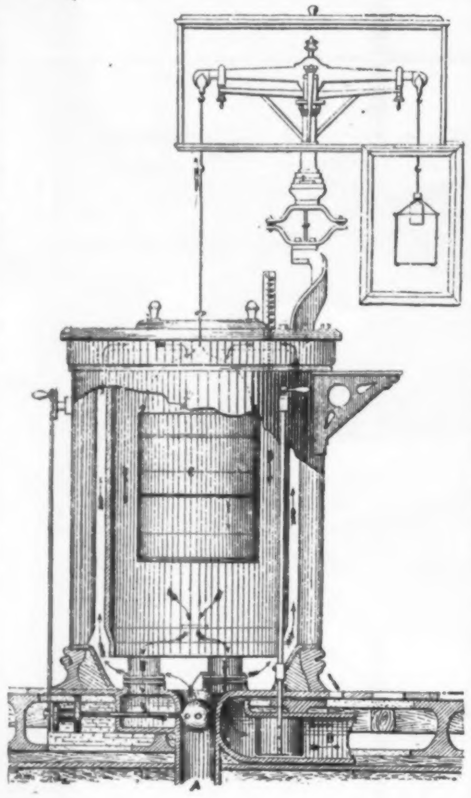
It would lead me too far now from my actual subject to deal with that question in a comprehensive way, and I will therefore mention only one important reason, viz., the fact that studies and inquiries about the proximate investigation of textile fibers and fabrics up to the present day are regarded as belonging much more to the province of botany, histology, or zoology than to that of analytical chemistry.[2]

From the practical point of view of textile industry, I hold quite an opposite opinion, and I have now to describe a system for the examination of textile fibers and fabrics, so as to ascertain their proximate constituents, which I think is convenient for all practical purposes.

A laboratory to be used for the examination of textile fibers and fabrics must be somewhat differently fitted up from that which is required for general chemical analysis; but although the microscope is a most important instrument for our purpose, it must not be regarded as the only means of making observations of this kind, as many have thought.

It is the continuous working into one another of microscopy and chemistry, or, better expressed, of microscopical and macroscopical chemistry, that is the special characteristic of all investigations upon textile fibers and fabrics.[3]

Any good microscope can be used for the purpose. I, however, especially recommend the use of one having revolving nosepieces for rapidly changing the objectives, an arrangement which is coming more and more into general use. Furthermore, it is of importance, in



A, hot air entrance. B, hot air exit. C, basket to contain material for experiment.

This apparatus, the invention of M. Storhay, has been modified in various particulars by Mr. Hermann Schlichter and myself. By using Perret's heating system, it can be maintained at a constant temperature for hours without danger of injury to the fibers.

making certain special observations, to use the well-known illuminating apparatus by Abbe[4] in conjunction with the microscope. It is self-evident that a micrometer is absolutely necessary for measuring the dimensions of the fibers.

As I proceed I shall describe the reagents which have to be used, partly in connection with the microscope and partly without it. Besides, there is especially one other kind of instrument which must be a chief feature in a laboratory for the examination of textile ma-

SILK.

terials, *i. e.*, an apparatus for determining the moisture of the fibers.

All textile fibers are hygroscopic,[5] some of them in a very high degree, and it is not sufficient to apply to them the methods which are used in general chemical analysis, because it is for practical purposes necessary to work with larger quantities (as regards weight and volume), in order to get the exact average of moisture.[6]

The apparatus[7] for such determinations is constructed in such a way that the substance to be dried is suspended in hot air of about 108° C., the air passing through the apparatus in a continuous current. Above the hot air chamber a chemical balance is fixed, an arrangement by which it is possible to weigh the substance while it is in the interior of the apparatus.[8]

This offers two advantages; the precise moment can be ascertained when perfect dryness is attained, and secondly, the prevention of reabsorption of moisture. It is, of course, understood that during the process of weighing the current of air has to be stopped.

All textile fibers are divided into three chief classes:

1. Those of vegetable origin;
2. All animal wools and hair; and
3. The different kinds of silks.

Now, if we get any textile material of unknown composition, the first fundamental experiment which we have to make is to examine some simple microscopical water objects of the material. If the subject is a raw product, a loose material, or a yarn, these objects are taken from different parts of the said material; but if we have a ready-made article, then the different parts of it have to be examined separately, *e. g.*, in rectangular textures, the warp and the woof.[9]

The simple microscopical properties of the textile fibers as they present themselves to the eye, moderately magnified, are well known, as follows:

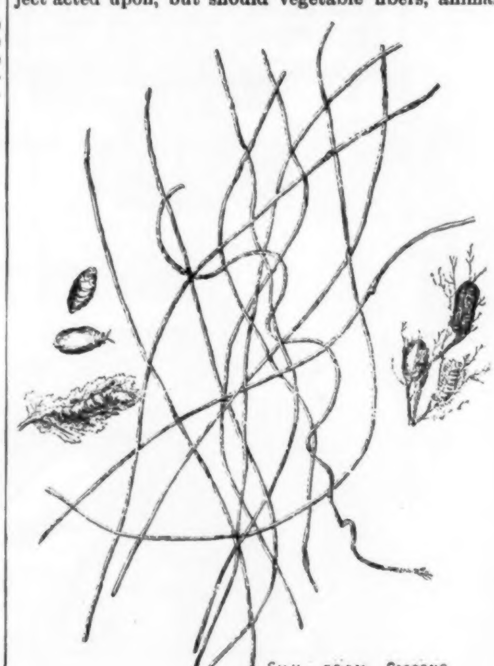
The fibroine fibers of all silks are uniform, and either entirely of a homogeneous structure or show simple longitudinal lines.

The fibers of animal wool and hair have either characteristic scales on their surface, or a central medulla, or both of these properties; and as regards vegetable fibers, which exist in a great number of different forms, the most important of them are characterized by their *lumen* (central cavity of these fibers), and in a negative sense they are marked by the absence of the qualities which we have seen to be characteristic of wool, hair, and silk.

But a knowledge of these simple characteristics is not sufficient, for fibers are inclined to vary. Natural causes as well as changes produced by artificial influences can affect the appearance and the qualities of the fibers in various ways,[10] the artificial influences being produced by the different kinds and modes of manufacturing. Hence it follows that it is necessary to assist microscopical examinations by chemical reagents.

First, let us observe the influence which cold concentrated sulphuric acid has upon fibers. If they are immediately dissolved by the acid, and little or nothing remains, then the substances are either silk or vegetable, or a mixture of both. But if the fibers are not rapidly dissolved, and epidermal scales appear standing out from the surface, we have wool or hair before us.

Secondly, let further microscopical objects be subjected to the action of cold concentrated hydrochloric acid. The fibers will be dissolved if real silk is the object acted upon, but should vegetable fibers, animal



SILK FROM COCOONS.
(The double fibres are separated.)

wool or hair, and Tussah silks[11] be the objects, the fibers will remain unchanged by the action of the said acid.

Thirdly, let a piece of the material to be experimented on be boiled for 10 minutes in a solution of 10 per cent. of caustic potash or soda, and then carefully rinsed and washed several times. The fibers of all kinds of silks, and wool, and hair are by this treatment dissolved,[12] but should anything remain, then the fibers can consist only of vegetable matter, the nature of which has to be ascertained by the microscope.

* A paper recently read before the Society of Chemical Industry, London.

[1] See note [26].

[2] The most important works of Wiesner, Vetillart, Nathusius, Bowman, etc., tend in the direction of botany, histology, or zoology. See Wiesner, "Rohstoffe," p. 298, and Hugo Muller, "Pflanzenfaser" (in the Vienna Exposition Reports), pp. 6 and 23.

[3] At any rate this is my own experience, after a long time of practical work on this subject. I was glad to find a similar opinion expressed by Cross, Bevan, and King, in their "Report on Indian Fibers and Fibrous Substances," 1887, in the following passage, p. 2: "Those authors (viz., Hugo Muller and Vetillart) have kept in the main to a distinct line of investigation, chemical or microscopical, only incidentally introducing the other, its essential complement. A method compounded of the two lines of inquiry must necessarily give a more complete account of the subject matter, and this we think will be found from the method about to be described." Now, on Hugo Muller's negative view on chemistry alone for the distinction of vegetable fibers from one another, see his "Pflanzenfaser," p. 23; therefore it might be expected that microscopy would have an essential part in all investigations, but with reference to the most important vegetable fibers, this is by no means the case in the above-named report, cotton and flax being treated quite insufficiently, and hemp not at all. This is much to be regretted when we consider what difficulty may arise in distinguishing hemp and flax fibers from each other. (See Schacht, Wiesner, Vetillart, Cramer, and Hohnel).

[4] The instrument used by me is constructed by Zeiss, in Jena.

[5] See Persoz, Sur le conditionnement, 1878, pp. 104 and 391; Bolley, "Spinnfasern," pp. 24 and 34; Hugo Muller, "Pflanzenfaser," p. 30, and others.

[6] See Persoz, Conditionnement, p. 163; Storhay, Renseignements pratiques sur les conditions publiques, 1888, p. 7.

[7] See drawing.

[8] See Talabot, Un procede nouveau sur la condition; Bolley, "Spinnfasern," pp. 36, 37; Persoz, Conditionnement, p. 146.

[9] See Hohnel, Mikroskopie, p. 106.

[10] See Hugo Muller, "Pflanzenfaser," pp. 23, 24; Hohnel, "Mikroskopie," p. 111.

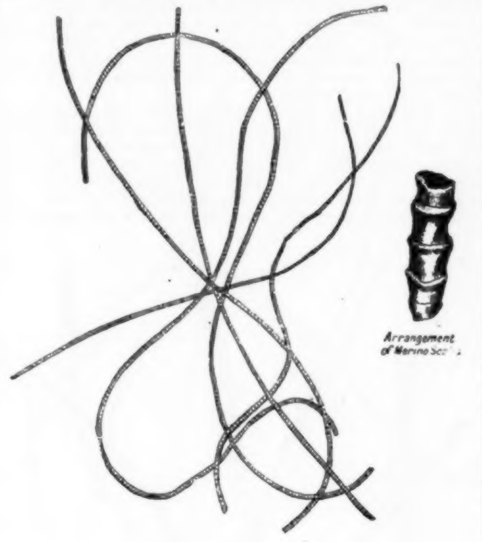
[11] See Wiesner and Prasch, Uber Seiden, in Mikroskop. Untersuchungen, pp. 45-54; Hohnel, Mikroskopie, p. 149; and Jour. Chem. Soc., 1888 (II.), p. 857.

[12] See Schacht, Gewebe, pp. 18 and 30.

Finally, we have to ascertain the presence or absence of Tussah silks. For this purpose boil a piece of material for a short time in concentrated hydrochloric acid, and examine microscopically. If a quantity of small but clearly defined portions of fibers manifest themselves with sharp and straight terminals, which very often show longitudinal lines, the presence of Tussah silks is proved.[13] Of course, other fibers may also be present, but this does not interfere with the reaction.

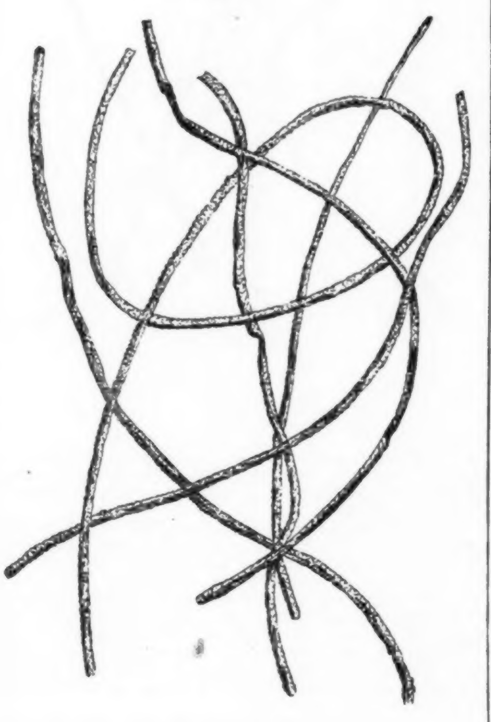
I now proceed to the quantitative distinction[14] of the several classes. For this purpose we take a piece of material, weigh it and put it into the drying apparatus, and as soon as it is entirely desiccated, weigh it a second time. By this means we find the hygroscopic moisture of the fibers. Then by boiling dyed and ready-made materials in highly diluted hydrochloric acid, we ascertain the amount of coloring matter, finish, dressing, etc.

Thirdly, we have to examine separately the various constituents found to be present by the preceding qualitative tests. If the substance is a mixture of *silk and wool*, we can dissolve the silk fibers in it with concentrated hydrochloric or with dilute sulphuric acid, and the wool will remain unchanged. After thoroughly washing them, we dry and weigh the remaining fibers, which will give us the amount of wool, that of silk being ascertained by subtraction. But if we have a combination of *silk and vegetable fibers*, the silk can be dissolved only in hydrochloric acid, and the result is obtained by proceeding as in the last experiment. Finally, *wool and plant fiber* combined are separated in a similar way, namely, by boiling the material in a weak solution of caustic potash or soda, wool being dissolved.



Arrangement of Merino Sc...

MERINO WOOL.



CROSS BRED WOOL

But should we have a compound of the three substances, wool, silk, and plant fiber together, we must proceed as follows: Wool and silk are simultaneously dissolved by caustic potash or soda, and the unaffected remainder will, of course, be vegetable fibers. Again, another piece of the same material being taken, we dissolve the silk and vegetable fibers by a weak solution of sulphuric acid, leaving the wool unaffected. The amount of silk is ascertained by subtraction. Of course, all weighings have to be made when the fibers are in a perfectly dry state.

Having now solved the preceding problems, we come to more detailed ones of the several classes before us. And this is the especial province of the microscope, for there are differences which can never be discovered by macroscopical means, owing to the similarities[15] existing in a great variety of substances. Let us begin with the VEGETABLE TEXTILE FIBERS. Only a limited number of them find at the present time extensive application in the European manufacture of textile fabrics,[16] and I therefore confine my remarks to the most important representatives of this class. Of course, the most important is *Cotton*. As a general rule the different kinds of cotton fibers are flat (band or ribbon like), with a plainly discernible lumen; and they have a peculiar way of being twisted corkscrew fashion.[17] While the cotton fiber is a kind of vegetable hair, *Flax* is a bast fiber of the linum, and is distinguished from cotton by its round or polyedric cross section. The lumen of flax is narrow, and the fiber, as in cotton, consists for the most part of pure cellulose. Again, flax fiber frequently shows joints transversely to the fiber, giving it an irregular and chain-like appearance.

The bast of *Hemp* is of similar construction to flax, but its cells are more irregular, its cell walls more resisting, and the lumen is sometimes of varying dimensions. But these peculiarities are not sufficient to show with accuracy and promptness the true differences between flax and hemp, for there are many flax fibers, especially those taken from the lower part of the stem, which are so very similar to hemp fiber that the one cannot even microscopically be distinguished from the other.

While pure flax fiber consists mostly of cellulose, and—in case of undyed fibers—with iodine and sulphuric acid gives a blue reaction, hemp in part contains woody substances, and therefore with the just named reagents may give green or yellow colors.[18] But this reaction is by no means general and conclusive, for there are many hemp fibers which show exactly the same result, as cotton and flax, in blue.[19] Therefore attempts have been made to find the difference between the fibers by micrometric observations of their diameters but unfortunately without any really satisfactory results.[20] A further distinguishing feature was supposed to exist in the appearance of the ends of the fibers in their natural state;[21] those of flax being assumed to be single, while those of hemp were thought to be double pointed. But then this difference is only partially correct, for many hemp fibers have been found terminating like flax in a single point.[22]

Finding all this insufficient to establish a true proximate analytical difference between flax and hemp, I tried another method which I found to give good and accurate results. The lumen of flax fiber always contains a certain amount of protoplasm[23] which is not destroyed by sulphuric acid, as cellulose is, but remains unchanged. Now the lumen of hemp very rarely shows the presence of protoplasm, [23] and hence hemp and flax fibers are very easily distinguished in this way the one from the other. Some microscopical objects subjected to the action of sulphuric acid of 75 per cent. will solve the question without difficulty. In both cases the cellulose of the fiber is quickly destroyed by the action of the acid. In the case of flax there remains the protoplasm of the lumen as a most distinctly marked line or narrow ribbon; while hemp shows nothing of this, but is quickly reduced to a more or less shapeless mass.

I find this method to be still easier and give better results if iodine is used previous to the application of sulphuric acid. Of course this is possible only when the material to be tested is *without dye*. I have referred to the reaction of iodine and sulphuric acid, which is well known as being highly characteristic for vegetable fibers.[24] It is for one reason only not of *general* importance for the proximate analysis of fibers and fabrics, as it can be applied only to undyed fibers.[25]

I find that it is, as a rule, insufficient and unsatisfactory to use solutions of one degree of strength in all experiments, as has been hitherto the rule exclusively,[26] for the best results are often lost owing to the improper strength of the reagents. I therefore recommend the following: The solution of iodine to be always the same, and consist, *e. g.*, of 1 part of potassium iodide in 100 parts of water, to which solution iodine is freely added.[27] But the sulphuric acid must be used in different degrees of strength. I use, for instance, a series of 25, 30, 40, etc., up to 90 per cent. of pure concentrated sulphuric acid.

I will now mention very briefly some other vegetable textile fibers[28] which are of more or less practical importance in addition to cotton, flax and hemp.[29]

China grass consists of bast fibers, the form of which is rather irregular, partly ribbon-like, partly round, and with a lumen varying in size. It never appears under the microscope rolled up in a corkscrew form, as is the case with cotton.

Jute is another kind of bast fiber material. The lumen often varies in width, a sign by which the fiber is easily distinguished from others.

New Zealand flax is a fiber obtained from the leaves of the plant producing it. It consists of cells, sharply pointed at the terminals, and circular in cross section, the lumen and cell walls being uniform throughout.

We now proceed to the second of our classes, viz., the different kinds of silks. Ordinary raw silk consists of double fibers which are coated with the so-called silk gelatine,[30] which is not a part of the fiber itself, and must be subsequently removed by boiling either in water or soap. The fiber throughout is a homogeneous and cylindrical body of fibroine. Besides genuine silk, other kinds of fibers of similar origin have been introduced into the silk trade, known by the collective name of *Tussah silks*.[31] They may be distinguished from genuine silk by various features.

COUNTRY WOOL

(Land Wolle)

COARSE WOOL

First it must be stated that their diameters are totally different,[32] that of real silk being much smaller and more uniform than that of Tussah silks.

Secondly these last silks show distinctly longitudinal lines in their fibroine fibers,[33] and also often coloring matter in the same,[33] these properties being absent in real silk.

Thirdly, a special property of Tussah silks is the un-

[13] At any rate, this is my own experience. About the collective name "Tussah Silks," see Hohnel, Mikroskopie, p. 150.

[14] See Remont, Jour. Phar. Chim., 1880; Chem. News, No. 1294; Jour. Soc. Chem. Ind., 1882 and 1884; and Persoz, Compt. Rend., 55.

[15] See Bowman, Structure of the Wool Fiber, p. 127; Grothe, Gespinnstfasern, p. 1; Wiesner and Prasch, Seiden, Micr. Unt., p. 54; and others.

[16] See Vetillart, Etudes, p. 252; Cross, Bevan, and King, Report on Indian Fibers, p. 1.

[17] Cotton may always be recognized very easily by these generally known features, no difficult investigation being necessary. See Bowman, Structure of the Cotton Fiber (plates); Hohnel, Mikroskopie, pp. 26 and 27; Vetillart, p. 141; Schacht, Gewebe, p. 23 and 24.

[18] See Schlesinger, Gespinnstfasern, pp. 13, 15, and 26; Hohnel, Mikroskopie, p. 36.

[19] See Schacht, Gewebe, p. 25.

[20] See the micrometric measurements in Vetillart, Etudes.

[21] See Schacht, Gewebe, pp. 21, 25, and 26; and compare Hohnel, Mikroskopie, pp. 37-39.

[22] See Schacht, Gewebe, table VI., Fig. 4, *a*; Vetillart, p. 77 and table 7; Wiesner, Techn. Mikroskopie, p. 110, and Rohstoffe, p. 376; Schlesinger, Gespinnstfasern, p. 26; Cramer, Programm d. Zurich Polyt., 1881.

[23] See Vetillart, Etudes, table 7; Hohnel, Mikroskopie, pp. 35 and 36; Hugo Muller, "Pflanzenfaser," p. 38.

[24] See Schlesinger, Gespinnstfasern, table, pp. 14, 15; Wiesner, Rohstoffe, p. 300.

[25] *Color Reactions*—such as reactions with iodine, phenol, phloroglucin and indol, nitric and picric acid, plumbite of soda, stannic chloride, sulphate of aniline, etc.—have hitherto been used to a great extent in distinguishing fibers. This is correct as long as the fibers are in a raw state, or are found in undyed materials. But as soon as the fibers are dyed, bleached, etc., as is well known to be the case in a vast number of textile fabrics, then the color reactions vary considerably. Hugo Muller and Hohnel share this opinion. It is for these reasons *that I have avoided color reactions as much as possible in my general analytical treatment of fibers, and substituted acids and alkalies as reagents*. The above named reaction of iodine and sulphuric acid refers to a special case, as is stated expressly.

[26] See Schachet, Gewebe, p. 8; Schlesinger, Gespinnstfasern, pp. 6 and 12; Wiesner, Rohstoffe, p. 300; Vetillart, Etudes, pp. 28, 29; each observer giving his own recipe.

[27] See Vetillart, Etudes, p. 28.

[28] Cross, Bevan and King (Report on Indian Fibers) seem to attach particular analytical importance to the *lengths of the ultimate fibers*. But although this is of high morphological importance, it is not of the slightest value analytically, because it is a practical impossibility to measure the lengths of fibers after they are spun into yarn and woven into textiles; especially when such fibers are many hundred times longer than broad (see Wiesner, Vetillart and Bowman). Wiesner, *e. g.*, has made the most minute investigations upon the lengths of fibers, and places particular morphological importance on it, but he *does not* use it in the analytical distinction of fibers. See Wiesner, Rohstoffe, p. 296 "Kennzeichen der Fasern;" p. 343, on distinction of cotton and flax; p. 375, of flax and hemp; p. 395, of jute, flax and hemp.

[29] Of the few following vegetable fibers only the chief characteristic features are given, because they are not of the same general importance as cotton, flax and hemp. Next to these comes jute, of which however Vetillart says (Etudes, p. 252): "Le jute ne se recommende par aucun autre avantage que son bas prix et la facilite avec laquelle on est arrive a le filer."

[30] See Bowman, Wool Fiber, Plate III.

[31] See Hohnel, Mikroskopie, p. 150.

[32] See Schlesinger, Gespinnstfasern, p. 42, and Hohnel, Mikroskopie, p. 152.

[33] See Schlesinger, Gespinnstfasern, pp. 43-44; Hohnel, Mikroskopie, pp. 144 and 145.

even thickness of the single fibers.[33] Genuine silk is quite uniform in this respect.

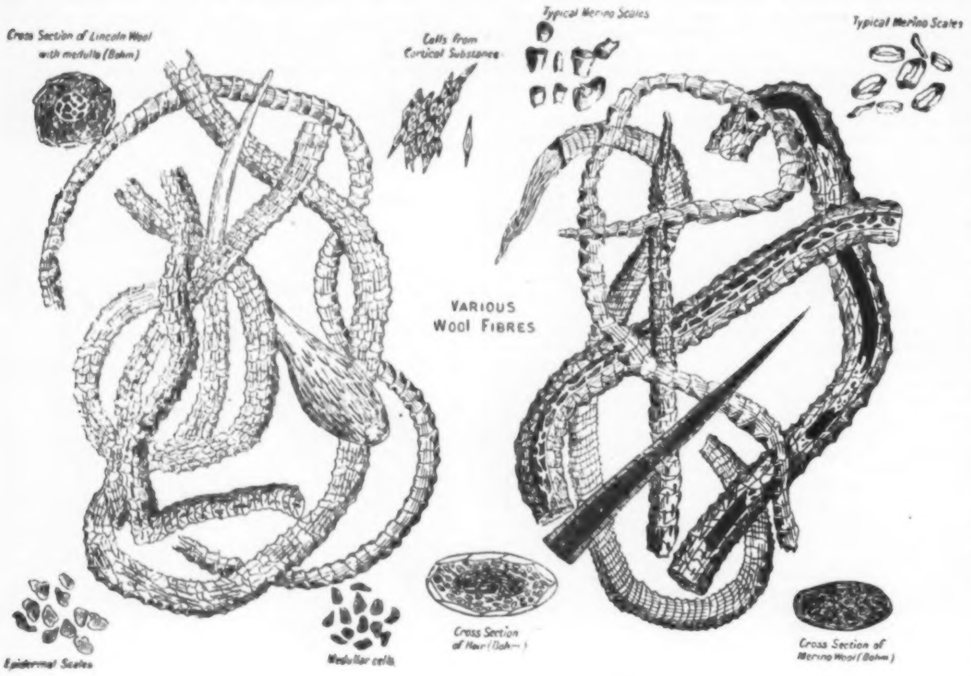
And lastly, in certain Tussah silks characteristic bands cross the fibers in an oblique direction,[34] the fibers appearing of a lighter color in these bands. They originate in two fibers crossing each other in the cocoon before they have become hard. If the contact takes place after the fibers have hardened, no bands are, of course, produced, and either the frequent appearance or the absence of the same is characteristic of many though not of all these silks, and forms another feature by which they may be distinguished from genuine silk.

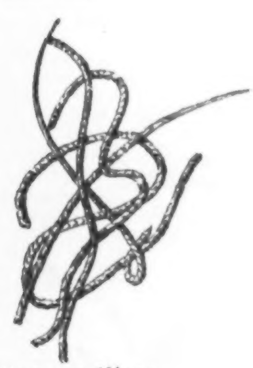
We see there is no difficulty in distinguishing real silk from other kinds, but if we wish to classify the silks, the best method is the micrometric measurement of their diameters. But until now this was possible only in a very incomplete manner, for the diameters of Tussah silks are very variable, as I have remarked before. Attempts have therefore been made to find the greatest diameter of any single fiber.[35] This may be done in a few instances, but to continue the operation each time in twenty or thirty cases with accuracy, and strike an average of the whole, is a practical impossibility.

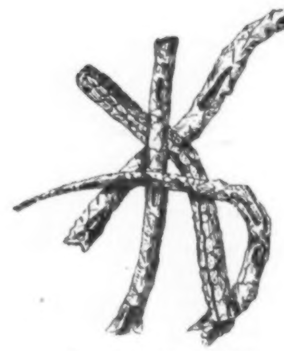
I have, however, found that genuine silk as well as all other kinds, if treated with caustic potash (Tussah silks may also be treated with hydrochloric acid), fall into a great number of very small particles which completely retain their original structure, and show sharp and straight terminals. These small particles are admirably adapted for an easy and perfectly accurate determining of the diameters, and besides this, they show the narrower parts of the fibers in a marked manner.

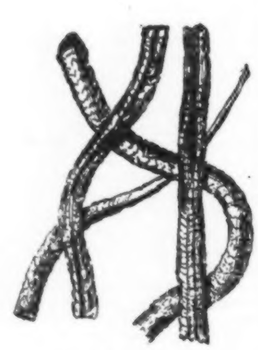
[34] Wiesner and Prasch, Uber Seiden, Mikr. Unt., pp. 45-54; Hohnel, Mikroskopie, p. 152.

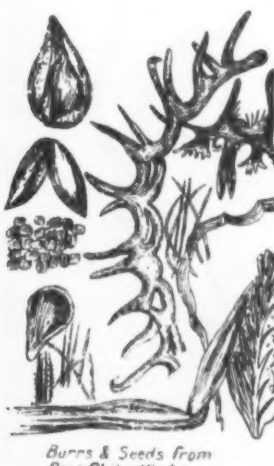
[35] Schlesinger, Gespinnstfasern, p. 42.

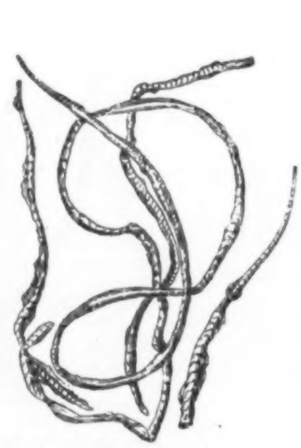


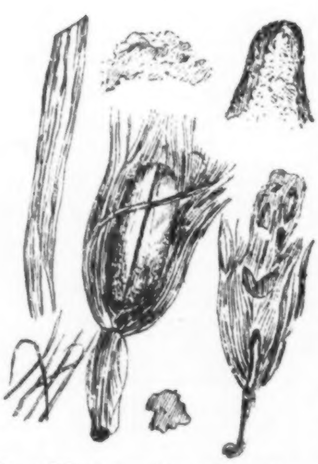

MERINO WOOL.


LEICESTER WOOL.


ALPACCA WOOL.


Burrs & Seeds from Port Philip Wool.


GREASY PORT PHILIP WOOL


Burrs & Seeds from Port Philip Wool

I found a peculiar passage in the second volume of the Journal of this Society, pp. 172, 173. Reference is made there to certain color appearances of the different kinds of silk. This passage is wholly unintelligible, for there can only be a question of polarized light, but this is not stated there. I do not know whether this inaccuracy has since been rectified, and I only mention the matter in case no such correction has been made.

The third of the classes of textile fibers is composed of all sorts of ANIMAL HAIR AND WOOL, the most important of which is the wool of the sheep. Hair and wool may be generally be described as compounded of three different parts;[36] the innermost is a cylinder containing the medulla, next comes a horny stratum of fiber, and externally is a scaly layer of epidermal cells. According to the nature of the wool, one or the other of these parts may be wanting, or may be of less importance. In many, especially the fine sheep wools, the innermost stratum—that containing the medulla—is absent, and the fiber gains thereby in uniformity and firmness.[37]

Among all animal fiber *sheep's wool*, of course, takes the first rank in practical importance. There are a great many varieties of sheep's wool,[38] as is well known, but all being absolutely equal in substance, the analytical investigation must be of an almost exclusively microscopic nature, chemical reagents finding only a subordinate place in their examination.

1. *Coarse wools*, in which many thick hairs are found in conjunction with the fine wool. The former are characterized by a thick central medulla, which constitutes the greater part of the fiber. In this class of wool the finer fibers differ materially from one another, and show no uniform features.

[36] See Bowman, Wool Fiber, Plates V. and VI.

[37] See Grothe, Technologie der Gespinnstfasern, p. 18.

[38] See the admirable treatment of this subject in Bowman, Structure of the Wool Fiber.

2. The so-called "*landwollen*,"[39] in which the finer fibers more predominate as in coarse wools, though thick hairs are always present. The finer fibers of this wool are frequently bent in an abrupt and irregular manner, and the diameters of single fibers are unequal.

3. The type of the crossbred wools has very long and strong fibers with very little inclination to curl. The fiber scales are very conspicuous, and the character of the wool itself is beautifully uniform, though the fibers are coarser than that of fine merino wools. A further characteristic feature is the absence of the medulla.

The so-called Lincoln and Leicester wools are relatives of the crossbred wools, to which they correspond in many respects. The medulla, although frequently absent, is not entirely so.

4. The most important and finest quality of all kinds of sheep's wool are the merino wools. The thinness, fineness, and uniformity of their fibers (coarse and stiff hair being entirely wanting) may be mentioned first. The total absence of the medulla is another feature connected herewith. Furthermore, the manner in which the epidermal scales are arranged is also characteristic. For these cup-like scales fit one into the other, foot into mouth, and consist of one piece.[40] In other wools this is not the case, for the fibers are not encircled by one single scale, but always by a combination of several scales.

As I have previously stated, hair and wool of all other kinds of animals are of much less importance in the manufacture of textiles than sheep's wool. But I might briefly state the ways in which some of the said wools and hairs differ from each other. The wools of the Angora goat[41] consist of a mixture of fine wool and coarse hair; they are comparatively stiff, uncurled, uniform, and covered with flat scales. The hair is characterized by the thick medulla in the middle, which gets gradually and uniformly thinner toward the top of the fiber.


FLAX FIBRE

Similarly constituted is alpaca wool, which is not curled, and is found usually in dark or black varieties. When black, the fibers are too opaque to allow anything of their structure to be discerned. But gently warmed with sulphuric acid of 60 per cent. strength, the scales separate from the body of the fiber; the fibers become partly lighter and semi-transparent, and it can easily be observed that the original color which, prior to the application of the acid, seemed to be uniformly black, is really a thick layer of natural brown coloring matter.

Very different from these are the thin, fine, and uniform fibers of vicuna wool, which are similar to camel wool and appear without scales. They are likewise not curled. In addition to fine fibers the vicuna wool contains thick hair which shows a strong medullar development. The fibers throughout manifest much natural brown coloring matter.

What is called camel hair is also a mixture of coarse hair and fine wool. The fine wool fibers are characterized in part by their having medullar cells or tubes. The difference of the development of the medulla in the coarser hair is furthermore characteristic, as it usually appears in all degrees and varieties. Camel hair always contains natural brown coloring matter in different degrees of intensity, varying from almost white to dark brown.

I have mentioned several times that textile fibers may contain certain quantities of natural coloring matter in their cells. In vegetable fibers and silks such coloring matters are practically only of subordinate importance, but in many cases it is essential to discover whether the brown color of certain hairs or wools is natural or has been given them by dyeing. It is not possible, however, to ascertain this by an

[39] There seems to be no special expression for this type of wools in the English language. At least, I could not get a collective name from practical people in the wool trade.

[40] Watson Smith, this journal, 1889, 20, Figs. 8 and 9.

[41] Bowman, Wool Fiber, plate 28.

ordinary microscopical observation,[42] and although the natural color will offer a greater resistance to reagents than artificial ones do, this property is by no means a general one. Moreover, as brown is the predominant shade of all nature-colored animal fibers, and this tint has few microscopical varieties artificially, this fact tends to make the matter still more difficult. But I may say I have found a practical and very simple method by which the natural and artificial colors of hair and wool can be distinguished the one from the other. For this purpose a microscope with Abbe's illuminator attached must be used. For a general examination of textile fibers, diaphragms with the smallest apertures must be employed with this instrument, in order to observe the structures of the fibers. But if animal fibers have to be examined, whether they are of a natural color or not, the objects must first be treated with a cold solution of caustic potash or soda, in order to produce swelling, by which the different parts and strata of the fibers become clearly visible.

HEMP FIBRES

COTTON

Now, if such objects be brought under the microscope and the diaphragms of the illuminator entirely removed, so that the whole aperture of the objective is filled by rays of light, then we get a view of the fiber which does not show much of its structure, but presents the color reactions so much the better. For, if the color is an artificial one, the fiber appears to be a homogeneous and uniformly dyed body; but if the color is natural, we perceive the coloring matter arranged in a peculiar way in certain parts of the fiber, forming there longitudinal stripes or lines, consisting of small points or grains, and this arrangement is so characteristic that a mistake is absolutely out of the question.

Another material which needs a peculiar method of examination is *shoddy*, which is used in conjunction with good wool. It is well known that large quantities of old woolen articles and cuttings, rags, etc., are worked up again, spun and woven a second time, and reappear in the market. Enormous quantities of shoddy are now annually produced in Great Britain and on the Continent, and because it is generally four or five times cheaper than new wools are, we can form an idea of the practical importance of the shoddy trade. But this introduction of shoddy into textiles is not always done "in good faith," but often the said material is palmed off as good wool, and the public pays for it a much higher price than it is worth. In fact, a great many materials, especially those made of short wools, are more or less adulterated with shoddy. From this fact we may learn the great importance of having correct analytical methods of proving the amount of shoddy in textiles. But to accomplish this many different things have to be observed, in order to test fibers whose structure and chemical properties differ from good wool only to a certain degree.

None of the methods[43] known hitherto gave correct results, and therefore I apply my own test, which is as follows:

All kinds of shoddy contain more or less vegetable fibers which are always to be found in old woolen articles, rags, etc., and which cannot be totally removed chemically from shoddy without damage to the shoddy. Frequently these vegetable fibers are dyed with different colors, according to their different origin. Now, after having made the tests to discover vegetable fibers in general, a piece of the material, which should be as large as practically possible, is weighed, then cut into pieces, and each of these pieces beaten in a mortar arranged for the purpose. Then the pieces are brushed on a specially prepared board, and what is brushed off is carefully collected. This having been done, the pieces are weighed again.

By this process a part of the shoddy is removed from the material, of course partly mixed with fibers of good wool, but these are brought into account, as we will see at once. The next step is to examine the brushed-off fibers most carefully under the microscope. Here shoddy always shows a great variety of features which are absent in good wool.

The most striking of these are:

1. Wool fibers of differently dyed colors.
2. Damaged wool fibers.
3. Vegetable fibers, partly dyed.
4. Small particles of wool fibers with brush-like ends.
5. Absence of epidermis of the wool fibers.

To these features others may come according to circumstances. I repeat a most minute and careful microscopic examination is necessary, in order to decide all these points. This examination also shows us the proportion of the shoddy fibers to the good wool fibers in these brushed-off parts. Then these parts, as well as the pieces of the material from which they were brushed, are dissolved in caustic potash or soda, each separately, the solutions filtered through fine platinum filters, and the vegetable fibers collected in both cases from the filters. The amount of these vegetable fibers is then ascertained in both cases either by weighing or by microscopical measurements.

Now experiments show that such vegetable fibers are always found uniformly divided in shoddy, and therefore we have the following calculation:

1. Original weight, a.
2. Weight of brushed pieces, b.
3. Weight of brushed-off fibers, $a-b$.
4. Amount of shoddy found by microscopic estimate in the brushed-off fibers $\frac{1}{x}$ of the total amount of these.
5. Proportion of vegetable fibers in brushed-off parts to vegetable fibers in brushed pieces $1 : m$.

Then it is evident that m times as much shoddy is contained in the brushed pieces as in the brushed-off fibers, and therefore the total weight of shoddy in the material is:

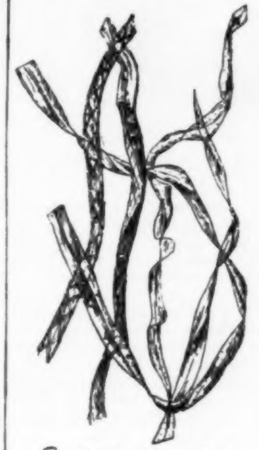
$$\frac{a-b}{x} + m\frac{a-b}{x} = \frac{a-b}{x}(1+m);$$

and the percentage of shoddy can easily be calculated from this.

I point out again that the factor $\frac{1}{x}$ is based on a microscopical estimate; the more exact this is, the more exact will be the final result.

It would remain for me to deal with the most important *hygroscopic properties*[44] of textile fibers and fabrics, and their analysis, as well as the analytical treatment of *raw products*, especially *raw wool*,[45] which contains, as you are well aware, besides moisture, a large amount of accessory substances, such as grease, sand, dust, burrs, etc. But this subject is too important to be treated only briefly at the end of this paper. Perhaps I may have an opportunity of dealing with it another time.

In conclusion I should like to mention that I am indebted to my brother, Mr. Hermann Schlichter, for the illustrations which appear with the paper. The drawings of the fibers have been made from microscopic observations, unless otherwise noted.



COTTON.

FLAX

CHINA GR.
(Ends of Fibres)

SHODDY ADULTERATIONS.

The fibers A B C D are dyed various dark shades.

JAPANESE LACQUER.*

JAPANESE lacquer is the product of a tree (Rhus vernicifera) which grows throughout the main island of Japan. It attains a large size, and will live for forty years, but only comparatively young trees are valued for the production of lacquer. Having yielded for several years they are cut down, the lacquer extracted from their branches, and young trees take their places. The best lacquer comes from Yoshino, in Yamato. The lacquer exudes from horizontal cuts in the bark, in the form of a rather viscid emulsion, and may be collected from April to the end of October. In the spring it is more watery than in the latter months. It exudes slowly and is collected by means of a pointed spoon-like instrument, and transferred to a wooden receptacle or tube of bamboo.

Several cuts are made in each tree, the last as high as a man can reach. Having thus prepared a dozen or more trees in rapid succession, the collector begins to collect the juice from the cuts in regular order, beginning with the one first cut. Having finished the collecting, he takes other groups of trees, and after about four days he returns to the first, where, after removing the accumulated yield, he cuts again into the same trees, and repeats the same process fifteen or twenty times. Thus the work may go on for eighty to a hundred days.

[42] See Hohnel, Mikroskopie, pp. 90 and 104.

[43] See Schlesinger, Gespinnstfasern, p. 62; Hohnel, Mikroskopie, p. 107; Focke, Arch. d. Pharm., vol. 24, p. 619. Hohnel's method is the best of these, but it cannot be applied for quantitative determinations of shoddy.

[44] See Musin: Observations sur le Conditionnement Hygrometrique des Matieres Textiles, 2 edit., 1877.
Persoz: Essai sur le Conditionnement, 1878.
Storhay: Renseignements Pratiques sur les Conditions Publiques, 1888.

[45] See Grothe, Technologie der Gespinnstfasern, p. 156. Zeitsch. d. Ver. d. Wollinteressenten, 1871.

* Paper read before the Washington Chemical Society by Romyn Hitchcock.

As the sap first exudes, it is a grayish white, thick, or viscous fluid, which quickly turns yellow, and afterward black, where it is in contact with the air. The sap thus collected is called ki-urushi; urushi being the general name for lacquer. An inferior kind is obtained from the branches when the trees are cut down. The branches are soaked with water for several months, then taken up and slightly warmed, when a small quantity of sap exudes. This is seshime-urushi. The lacquer is strained through cotton cloth to free it from bits of wood and dirt, first being thoroughly stirred to break up lumps and make a uniform mixture. The product thus purified is known as seshime-urushi, but this name, which has already been used to designate the lacquer from the branches, has now a different meaning, and is applied to the cheaper kinds of raw lacquer, such as are used for the first coats in lacquering. These lacquers have usually lost some of their water by stirring in shallow receptacles exposed to the sun. They have undergone no further preparation. Many varieties are prepared for special purposes, ranging in price from one or two to six or seven dollars per kilogramme. These differ in quality and color. There is a famous black lacquer prepared by the addition of iron, which forms a chemical combination to be mentioned further on; while red, green, yellow, and other colors are imparted by the addition of various pigments, as cinnabar for red, orpiment and indigo together for green, orpiment for yellow, etc. Certain lacquers have a small proportion of drying oil (perilla oil) added to them. The most important and abundant constituent of lacquer is urushic acid, which occurs in the form of minute spherules. The acid is obtained by evaporating the alcoholic solution to a sirupy liquid. The evaporation must be carried on over a water bath. If too much heat be applied, a tough, black, rubber-like substance is obtained, which only strong nitric acid would affect in the slightest degree. Although the drying or rather the hardening properties of lacquer are doubtless due to the oxidation of urushic acid, the product extracted by alcohol possesses no drying qualities. This fact was first observed by Professor Rein, in 1874.

More recently, Professor Korschelt and Yoshida have found that a peculiar albuminoid of lacquer effects the drying by a diastatic or fermentive action. The fact seems to be that the lacquer hardens only when the albuminous substance is present. If heated above 60° C., or above the temperature at which albumen coagulates, the lacquer will not dry. Besides urushic acid and the albuminoid, raw lacquer contains a gum resembling gum arabic, which doubtless imparts some useful properties to the lacquer, and a volatile acid, to which Prof. Rein ascribes the poisonous effects of lacquer. A portion of raw lacquer, about 16 pounds, is poured into a large circular wooden vessel, and vigorously stirred with a long-handled tool for five or six hours, while the heat of a small charcoal furnace is ingeniously thrown upon the surface to evaporate the water. During the stirring certain ingredients may be added from time to time. The roiro, the fine, black lacquer already mentioned, is made by adding iron at this stage. In Tokio a soluble salt of iron is used, but the Osaka manufacturer objects to that, asserting that it injures the quality of the lacquer. The material used in Osaka is the fine iron dust collected from the grinding of knives. This is added in quantities of about a teacupful of powder mixed with water at a time, until the desired color is obtained. When the work is finished, the lacquer is poured into a vessel to settle and is afterward drawn off the sediment.

THE ALARM WATCH.

THE invention of the morning alarm dates from a remote epoch. Ancient authors speak of instruments applied to clepsydras in order to produce a noise.

Ctesibius adapted flutes and trumpets to the improved clepsydra. Athenæus attributes the invention of the first horary call bell to Plato, and in Eginhard we find a description of the wonderful machine that the Caliph of the Abassides, Haroun-al-Raschid, sent to Charlemagne as a present. It rang the hours by means of small iron balls that fell upon a brass bell.

Without going back to the time of the Greeks, Romans, or Arabians, and confining ourselves to the history of horology, properly so called, we find that in all times and from the beginning, the mechanician has occupied himself with the production of a noise and the adaptation to his clockwork movement not only of a device that could count and strike the hours, but of an alarm capable of marking in a special manner the precise hour that had been determined on in advance.

Alarm clocks were made at the time of Charles VII. Complicated watches were manufactured as far back as the sixteenth century. Finally, under the reign of Francis I., there were enough clockmakers in Paris to form a corporation, whose statutes have been preserved to us. Article 3 says: "No one shall be received as a master of the said art unless his habits of life be good, and unless he has made and completed some masterpiece which shall be at least an alarm clock."

The sonorous part that was then employed and that was used for a long time afterward was, for striking watches as well as for clocks, the ordinary gong of bell metal. Enough sound was obtained, provided the gong was large enough. That was easy enough as far

FIG. 2.—RIOLET'S NEW ALARM WATCH.

as clocks were concerned, on account of the wide space therein; but in a watch the space is limited, and this is why we find it difficult to believe what is related of the Duke of Urbino, who in 1542 is said to have owned a ring in whose bezel there was a watch that struck the hours.

In old alarm watches it was the form of the bell that made it necessary to have the case thick and of a rounded form. Some cases were enameled, but most were decorated with chased figures and ornaments. We present herewith two engravings, Fig. 1 representing two of these watches figured to a scale of one-half. The first of these watches is of French make, and dates

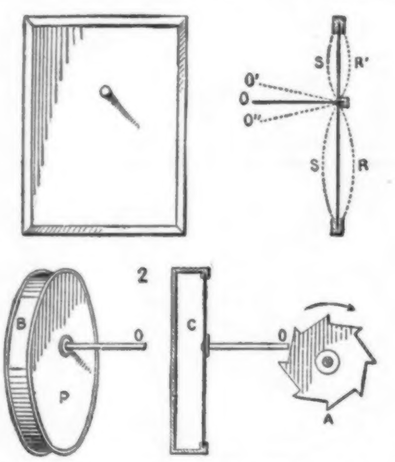


FIG. 3.—PRINCIPLE OF THE RIOLET ALARM WATCH.

back to the beginning of the seventeenth century. It belongs to the Jacquart collection. The other is not so old. It is one of those alarm watches that were manufactured in London, and the double case of which was in open work and finely engraved.

After the bell spring of repeating watches was invented, it was applied to alarm watches, and it became possible in that way to much reduce the bulk of the latter, but the sound was reduced in a like measure. This is so feeble, in fact, that it can be heard only by listening attentively, and hence the watch ceases to become a morning alarm. Other devices for producing a sound have been sought for, and various kinds have been invented. One of the boldest of these consists of a hammer, quite similar to that of a gun, which at a given moment strikes a percussion cap and produces a detonation. We believe it to be useless to describe the drawbacks of such a system.

The problem has therefore for a long time been this: How is it possible, under a small bulk, to produce a loud enough sound to attract the attention of an occupied person or to awaken him?

It will be remembered that there was a certain toy that served to amuse all Paris for several months. During the entire summer of 1876, the "cricket" was heard in all the streets, at the railway stations, and as far as to the most distant villages. Every child and every Sunday traveler had in his pocket this two cent trifle made of a strip of thin steel whose every effort made a sharp, strident sound.

Mr. Riolet, struck by this toy, conceived the idea of setting a plate of tempered steel in a bezel and making it vibrate through a steel finger riveted at right angles to the surface of it. This finger enters the watch movement, and there meets with a toothed wheel provided with a spring which is freed by a detent, and through this gives a vibratory motion to the plate.

The plate acts like the head of a drum, and the sound of it becomes so much the sharper and clearer in proportion as it is rendered tighter. So in the watch under consideration, it is no longer the measured and slow "cricket" of the Parisian urchins, but rather the strident song of the cicada. It is for this reason that the figure of the insect is engraved upon the case (Fig. 2).

The following are the details of the arrangement adopted. If, in a frame, we inclose the edges of a perfectly plane disk of tempered steel to which is fixed at one point of its surface, and at right angles with it, a lever firmly held by a rivet; and if, on another hand, we raise this lever by its extremity O (Fig. 3, No. 1), and afterward leave it to itself, we shall obtain a vibration from O' to O'' which will be communicated to the plate. The curves S S' R R' indicate the rapid and alternate motions of the disk.

The sound obtained in this case is that of a dead blow produced by the impact of the plate upon the air, the latter being violently driven forward through an energetic action due to the intensity of the molecular tensions that have been developed. The intensity of the sound produced by this means has, so to speak, no other limits than the dimensions and thickness of the metallic plates used.

Fig. 3, No. 2, represents the arrangement adopted in the new alarm watch called the "Cicada:" B is the frame in which is set the tempered steel disk, P. O is a lever firmly riveted to the disk. C is the head of the rivet.

A is a toothed wheel revolving in the direction shown by the arrow, and actuating the extremity of the lever, O.

In its rotary motion, each of the teeth of the wheel, A, produces a vibration of the disk, and as the sound is in direct ratio of the number and velocity of the vibrations, it follows that in order to obtain a maximum of sound, it will suffice to regulate the velocity of the wheel, A.—*La Nature.*

THE PROPERTIES OF ALUMINUM, WITH SOME INFORMATION RELATING TO THE METAL.*

PURITY OF ALUMINUM AND PROCESSES OF MANUFACTURE.

A GREAT deal that has been written heretofore about the properties of aluminum is of doubtful value, owing to the lack of knowledge we have of the purity of the aluminum referred to. Much of the metal heretofore sold in the markets as pure aluminum has been contaminated with from 4 to 10 per cent. of impurities. Indeed, it is only within a very few years that a purer metal than 95 per cent. aluminum has been made upon any larger than a laboratory scale.

The works of M. Pechinet, of the Societe d'Anonyme d'Aluminum, at Salindres, near Marseilles, in France, have long enjoyed the reputation of making the purest aluminum placed upon the market. The method employed is essentially Deville's, reducing aluminum chloride by aid of metallic sodium, the same as practiced by the Aluminum Co., limited, at Oldbury, England; with the modification of using aluminum fluoride, instead of aluminum chloride, to be reduced by the sodium. This is also the method pursued by the Alliance Aluminum Co., of Wallsend-on-Tyne, in England.

The Pittsburg Reduction Co., manufacturing under the Hall process, reduce the metal from aluminum oxide, alumina (Al_2O_3), by electrolysis; this alumina being held in solution by a molten fluoride bath, which itself is not decomposed by the electric current, which is conveyed to the melted solution by means of carbon cylinders placed in the bath for positive electrodes, a carbon-lined pot forming the negative electrode. The oxygen of the alumina goes off at the positive electrode as carbonic acid, wearing away the carbon at the rate of nearly a pound of carbon to the pound of aluminum produced. The reduced metal settles to the bottom of the pot, from which it is easily tapped or ladled off, practically free from the electrolyte; a second remelting entirely purifying from it.

All four of the above firms have succeeded in making aluminum of 99 per cent. purity, although it is only with careful selection of materials, and the greatest care to prevent contaminations, that metal of this purity is obtained by any of these processes. All of these firms have succeeded in regularly placing upon the market metal in considerable quantities of over 98 per cent. purity, and these are the only firms, so far as has reached the knowledge of the writers, who have done so.

The impurities of the metal made by "the sodium process," as practiced by the first three mentioned concerns, have been nearly half iron and half silicon. With the Pittsburg Reduction Co. the impurity consists almost entirely of silicon; the iron being less than one-tenth of one per cent. Between December 1 and December 24, 1889 (the plant was shut down for repairs, the first time since November 28, 1888, from

* A paper, by Alfred E. Hunt, Jno. W. Langley, and Chas. M. Hall, read at the Washington meeting of the American Institute of Mining Engineers.—*Engineering News.*

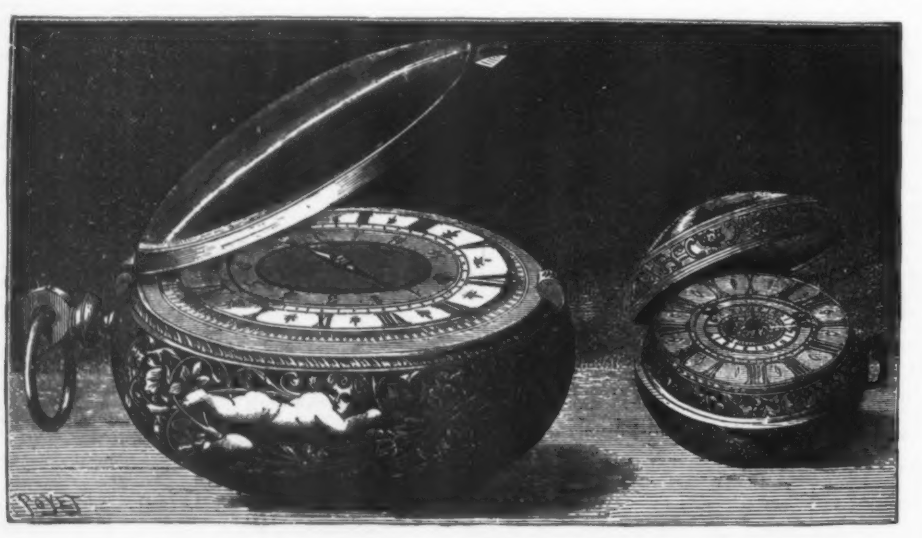


FIG. 1.—ALARM WATCHES OF THE SEVENTEENTH CENTURY.

the day before Christmas until New Year's), 1,250 lb. of aluminum was made by the Pittsburg Reduction Co., all of which was over 98·25 per cent. aluminum, with less than 0·10 per cent. iron, and with about 1·50 per cent. silicon; and quite an amount of this metal was over 98·75 per cent. aluminum.

A singular fact is that quite a portion of the silicon in aluminum exists in the graphitoidal state. This was pointed out by Mr. H. J. Williams, when chemist of the Pittsburg Reduction Co., in Trans. Am. Inst. Mining Engineers, vol. xvii., page 542, and also was recognized by Deville in his researches. In aluminum containing 0·20 per cent. silicon, made by the Alliance Aluminum Co., limited, we have found 3·85 per cent. of graphitoidal silicon. In a sample of aluminum made by the Pittsburg Reduction Co., using calcined native bauxite as an ore, containing 5·30 per cent. silicon, 2·50 per cent. existed in the graphitoidal state.

The following table gives the average composition of the metal of the various makers of given percentages of contained aluminum, as shown by many analyses made by the Pittsburg Testing Laboratory:

Aluminum metal made by	Per cent. aluminum.	Per cent. combined silicon.	Per cent. graphitoidal silicon.	Per cent. iron.	Per cent. copper.	Per cent. sodium.	Per cent. lead.
The Pittsburg Reduction Co.	95·0	1·50	1·35	2·00	0·07	0·04	0·03
The Societe d'Anonyme d'Aluminum...	95·0	0·90	1·00	3·00	0·05	0·01	0·04
The Alliance Aluminum Co., Ltd.......	95·0	0·90	0·75	3·25	0·02	0·07	0·01
The Aluminum Co., Ltd., Newhausen..	96·0	1·75	1·15	2·00	0·01	0·07	nil.
The Societe d'Anonyme d'Aluminum..	99·0	0·35	0·13	0·50	nil.	0·01	0·01
The Alliance Aluminum Co., Ltd.......	99·0	0·31	0·20	0·45	nil.	0·03	0·01
The Aluminum Co., Ltd..............	99·0	0·27	0·15	0·55	0·02	0·01	nil.

PROPERTIES WITH REFERENCE TO SPECIFIC GRAVITY.

One of the most striking properties of aluminum is its lightness, which, for many purposes, makes it comparable in value with metals costing one-fourth as much.

[The author here gave a table of specific gravities as determined by various authorities. Roscoe & Schorlemmer give 2·56 for cast metal and 2·67 for hammered metal. Deville gives 2·60 for cast metal, absolutely pure, at 4° C. The Pittsburg Testing Laboratory found 2·587 for a bar sawed from the center of a cast ingot, and 2·71 for an average lot 98·52 per cent. aluminum in sheets 0·0625 inch thick.]

The specific gravity of aluminum being taken as 1, soft steel is nearly 2·95 times as heavy, copper 3·6 times as heavy, ordinary high brass 3·45 times as heavy, nickel 3·5 times as heavy, silver 4 times as heavy, lead 4·8 times as heavy, gold 7·7 times as heavy. A sheet of aluminum 12 inches square and 1 inch thick weighs 14·03 lb.; a bar of aluminum 1 inch square and 12 inches long will weigh 1·17 lb. A bar of aluminum 1 inch in diameter and 12 inches long will weigh 0·918 lb. A cubic inch of cast aluminum weighs 0·092 lb.

One cubic foot of cast aluminum weighs 158,967 lb., 1 cubic foot of wrought iron weighs 485,874 lb., 1 cubic foot of ordinary brass weighs 524,160 lb.

Aluminum has about the tensile strength of cast iron, with only about one-third of its weight, and casts equally as easily and successfully, and will, therefore, be very advantageously used to replace cast iron in the parts of moving machinery that have to be reversed or otherwise have their momentum overcome; for with one-third the weight, and consequently one-third the momentum, aluminum will work very satisfactorily.

ACTION OF HEAT ON ALUMINUM.

Pure aluminum melts and become fluid at about 1,200 Fahr. The amount of impurity in aluminum materially alters its melting point. One per cent. of iron raises the melting point over 100°. It does not remain firm like lead almost to the fluid point, and then suddenly give way, but has a stage of from 1,000° Fahr. to 1,200° Fahr. in which the metal becomes pasty, loses much of its power of cohesion, and during which stage, if the metal be gently pressed together, it can be readily welded. It is, however, very red-short at this temperature, and will not stand hammering to weld the metal without crumbling down. If the metal is not held too long a time in this pasty condition, it does not seem to become injured after being again cooled down.

The Thomson Electric Welding Co. have no difficulty in satisfactorily, rapidly, and cheaply welding aluminum in such ways that the welded strip will break in the body of the bar, by their admirable machines, which are so designed that the surfaces to be welded are brought together automatically at the welding temperature (near the fusing point in many metals, and a temperature at which the rigidity is nearly lost in them all), in just such a way that the welded faces will cohere without changing the form of the constituent parts.

The melting point of aluminum, as given by Roscoe & Schorlemmer and by Mierzinski, is 700° C., or 1,292° F.; by Deville, at a temperature higher than zinc and lower than silver; by Fahquhardt, at 760° C., or 1,400° Fahr.

Mallet says pure aluminum is more infusible than impure.

The metal of the Pittsburg Reduction Co. has been subjected to many tests, which will be referred to later in this article, and for the sake of brevity in identifying it we shall call it the Pittsburg Reduction Co. "average lot 98·52 per cent. aluminum."

The metal was of the following composition:

Al, 98·52 per cent. Si combined, 0·42 per cent. Si graphitic, 0·72 per cent. Fe, 0·05 per cent. Cu, 0·06 per cent. Pb, 0·04 per cent. As, none. S, none. P, none. Ca, trace. Na, trace.

Aluminum, in a compact mass, is an absolutely "fixed" metal, at any temperature attainable by combustion of carbon in the most approved furnace, although in thin beaten foil aluminum burns in a current of oxygen gas. An experiment made by one of the authors, by heating a weighed amount of aluminum in a carbon-lined crucible for several hours—in a Sefstrom furnace, at a temperature considerably above the melting point of steel—showed that the resulting buttons of aluminum contained all the original aluminum melted, plus several per cent. of carbon, which formed a tenacious, closely adhering skin upon it. The metal, however, had become quite brittle and had largely lost its cohesive powers. Deville, Watts, and Fremy all say that aluminum is absolutely fixed at all temperatures and loses no part of its weight when highly heated.

Aluminum remains in a molten condition without any slag over it, and requires no flux; indeed, most fluxes are absolutely injurious, in that they assist the metal in absorbing silicon and iron from the lining walls of the containing crucible; charcoal and other light substances which are sometimes used to cover the molten bath are very difficult to keep from contaminating the castings, and are of no use whatever.

Molten aluminum takes a very thin coating of oxide of aluminum on its surface, which seems to protect the liquid metal underneath it. This thin coating can be discovered by drawing a rod of aluminum across the surface of the bath and noting the brightened surface of the metal in the stroke made by the rod parting the surface film. It is not our experience that this film of oxide is of serious consequence in preventing sound castings or causing flaws in rolled sheets or bars.

Aluminum had best be melted in first quality plumbago crucibles, from which it absorbs only about 0·25 per cent. silicon with each remelting. In melting in clay, Battersea, or other silicious crucibles, aluminum becomes very seriously contaminated with silicon.

For purposes where it is especially desirable to retain the purity of aluminum, it is best to remelt in crucibles brasqued or lined with a mixture of finely ground, "dead burned," calcined, pure magnesia, with just enough boiled tar to give it sufficient plasticity; this mixture entirely prevents the molten aluminum from coming in contact with the silica in the clay of the crucible walls.

Heated in an atmosphere of chlorine gas, aluminum burns to a chloride. Moist chlorine gas, even in the cold, acts energetically upon aluminum.

Aluminum is most malleable at a temperature between 200° and 300° Fahr., although it can be rolled cold with frequent annealing. It should not be worked at a temperature above 400° Fahr., for it becomes very red-short at a temperature a little above this point. Aluminum becomes quite hard by work upon it, either by cold-rolling, hammering, or drawing. Through wire dies it assumes nearly double its normal tensile strength, although it does not, like steel, lose proportionately as much of its ductility as measured by the flow of the metal in reduction of area at point of fracture. In rolling or drawing aluminum, like the precious metals, it requires frequent annealings to prevent its cracking.

This annealing is accomplished by heating the metal to a temperature of about 800° Fahr. It is a temperature at which a thin bar of iron placed in the muffle will just appear slightly red on a dark day or at twilight. The aluminum at this temperature should not appear at all red. This temperature can best be determined in a practical way by drawing a soft pine stick across the surface of the aluminum to be annealed; it should leave a black mark from the charring of the wood, which should burn off very slowly, or not at all. After being heated to this temperature the metal should be allowed to cool off very gradually, although a very satisfactory annealing of light articles can be attained by plunging them in water of between 60° and 100° Fahr.

For some articles, where it is necessary to keep the heat down below the point where the metal would sag or lose its shape, a very satisfactory annealing can be done by heating the articles in boiling linseed oil and allowing them to gradually cool with the oil. Very thin sheets and wire can be annealed by plunging into boiling water and allowing to cool with the water. Aluminum as annealed is very soft and pliable indeed; in fact, as compared to its tenacity, it is probably the most pliable of metals.

Aluminum on slowly cooling from fusion crystallizes in octohedrons, and castings on fracture show a fine-grained crystalline structure. Pulled in a testing machine, the fracture shows granular.

An ingot of aluminum high in silicon was melted in a plumbago crucible, and one portion cooled in a very cold and thick-walled ingot mould, into a very thin ingot, in a way to give the metal as much of a chill as possible; the other portion of the metal was cast in a hot mould and into a thin ingot. The metal of the outside of each ingot was analyzed, with the following results:

	Metal chilled rapidly. Per cent.	Metal cooled slowly. Per cent.	Original, metal as first made. Per cent.
Aluminum..................................	96·55	96·52	96·60
Iron....	0·24	0·24	0·24
Combined or amorphous silicon.......	1·08	1·34	1·24
Graphitic silicon	2·13	1·90	1·92

So far as it will be fair to generalize from this single experiment, graphitoidal silicon is not rendered amorphous, or combined, as would be the case in chilled iron, under the same circumstances. To support this view, no appreciable difference in hardness can be determined between surfaces of ingots cast in chills over those cast in hot moulds.

The specific heat of aluminum is 0·2143, water being taken as 1·000. As given in Richardson "Aluminum."

"Mallet gives the specific heat of aluminum as 0·2253.

"Fremy gives the specific heat of aluminum as 0·2181."

Aluminum follows the general rule of specific heats—that they are inversely as the atomic weights.

Aluminum expands under heat as follows:

The coefficient of linear expansion, as determined by one of the authors of this paper, of rolled rods of aluminum (of the average of the Pittsburg Reduction Co.'s 98·52 per cent. aluminum above described) is approximately, per degree Centigrade between the freezing and boiling points of water, 0·0000206; that of wrought iron, by the same method, being 0·0000122. From this it is apparent that aluminum has a coefficient of expansion closely approaching that of tin, which is 0·0000217, and higher than copper, which is 0·000017182.

Sound castings can be readily made of aluminum, using dry sand moulds. The moulds can be advantageously lined with plumbago. The metal should be poured quicky, and at very little above the melting point; otherwise the castings will be unsound. Molten aluminum floats readily, and not much larger gates are needed than with brass.

The shrinkage of average aluminum castings made by the Pittsburg Reduction Co. is about 0$\frac{17}{64}$ inch to the foot, as measured by an Olsen's shrinkage testing machine. The shrinkage can be reckoned to be about 2·26 per cent. of the length of the mould ordinarily.

CORRODIBILITY.

Aluminum becomes covered by a very thin, almost imponderable, coating of oxide on its surface exposed to the atmosphere, which seems to protect it from further oxidation This coating is so thin as to hardly in any way interfere with the surface polish which the metal takes, and does not change the weight of the metal as determined by the most delicate of chemical balances. In the chemical laboratory of the Pittsburg Testing Laboratory we have a thin weighing scoop hammered out of an aluminum sheet, which weighed 2·2086 grammes eight years ago; it has not changed in weight one-tenth of a milligramme since. The popular general statement that aluminum is unacted upon by air, either moist or dry, or by water, is, therefore, practically true.

According to Deville, water has no action on aluminum, either at ordinary temperatures or at the boiling point. The accuracy of this statement the authors have very frequently verified, finding aluminum wire subjected to the action of steam and heated air to retain its original polish and not to lose weight after six hours' exposure.

Aluminum containing sodium is rapidly acted upon by hot water, dissolving out the sodium and leaving the aluminum spongy and weak, fit only to be remelted, whence it comes out purer and better in quality for its freedom from the sodium.

Aluminum is unacted upon by either concentrated sulphuric or nitric acid; hydrochloric acid is its natural solvent; and when either sulphuric or nitric acid is contaminated with any hydrochloric acid, even though in very small proportions, they rapidly corrode aluminum; the hydrochloric acid forming chloride of aluminum, which in turn is converted into sulphate or nitrate, the hydrochloric acid being again set free in a nascent state, to again attack the aluminum, and in this way the corroding chloride acts as a carrier for the sulphuric or nitric acid.

Aluminum is unacted upon by sulphureted hydrogen, carbonic oxide or carbonic acid gases, or by sulphurous acid or other sulphur vapors. The facts add much to the value of aluminum for many purposes where the tarnishing of silver is a serious inconvenience.

It is also practically unaffected by common salt, either wet or dry, or by sea water, or by weak solutions of salt in acetic acid.

A piece of aluminum $3\frac{3}{8} \times 1\frac{1}{8} \times \frac{1}{32}$ inches was immersed for 23 days in a 3 per cent. solution of common table salt, at a temperature of 80 Fahr. The strip lost 0·025 gramme in weight; 4·27 square inches were exposed; this would give a loss by corrosion per sq. in. per week of 0·00178 gramme. A similar strip was immersed for a similar length of time, under like conditions, in a solution of 3 per cent. common salt with 2 per cent. of No. 8 acetic acid. The action in this case was not confined to that portion immersed in the liquid, but a crust of basic salts was also formed on the portion of the plate above the liquid. The strip was frequently reversed end for end in order to equalize the action. This piece lost 0·165 gramme upon an area of 6·4 in., and the loss was at the rate of 0·00785 gramme per sq. in. per week.

These solutions were chosen as fairly representing extreme conditions to which aluminum would be subjected for domestic culinary operations. This corrosion is very slight and of no practical consequence, being much less than tin plate or silver plate would suffer under similar circumstances.

Solutions of the caustic alkalies readily attack aluminum. In ammonia, aluminum is turned gray in color, but does not lose weight or strength. Chlorine, bromine, iodine, and fluorine attack aluminum and corrode it.

Aluminum is unacted upon by organic secretions, such as sweat, saliva or the like, and the metal is finding considerable uses by dentists in the metal plates upon which to back false teeth, as well as by surgeons in tracheotomy tubes, etc.; for these purposes, the aluminum should be free from iron, as it is found that where iron is present in the aluminum, the metal is acted upon by the saliva.

MECHANICAL PROPERTIES.

Aluminum naturally is very soft metal.

The results of a drop testing machine of the Pittsburg Testing Laboratory, in which an accurately ground hardened steel point of 60 degrees, centrally fixed in a weight of 32 lb., falling in guides a distance of 24 inches, were as follows:

	Material.			Kind.	Depth and diameter of point mark.
1.	Aluminum	¼ in.	thick....	Rolled	0·140 × 0·28 in.
2.	"	"	"	"	0·144 × 0·30 "
3.	"	"	"	"	0·143 × 0·30 "
4.	"	½ in.	"	Cast	0·176 × 0·32 "
5.	"	"	"	"	0·177 × 0·32 "
6.	"	$\frac{17}{32}$ in.	"	"	0·145 × 0·29 "
7.	"	"	"	"	0·144 × 0·29 "
8.	"	¾ in.	"	"	0·177 × 0·32 "
9.	Brass	$\frac{7}{32}$ in.	"	"	0·145 × 0·26 "
10.	"	"	"	"	0·142 × 0·26 "
11.	"	¼ in.	"	Rolled	0·129 × 0·24 "
12.	"	"	"	"	0·129 × 0·24 "
13.	Copper	$\frac{7}{32}$ in.	"	"	0·111 × 0·24 "
14.	Zinc	¼ in.	"	"	0·118 × 0·24 "
15.	"	"	"	"	0·111 × 0·24 "

These results show only partially the difference in the surface hardness, due to working aluminum when cold; castings of aluminum made a little larger than the finished object desired, and drop-forged in dies, are very considerably hardened and made more rigid. For many bearings where great weight does not have to be sustained, as for bearings of surveying instruments, the metal hardened in this way answers very satisfactorily.

Wire and sheets of aluminum can be left in this hard-

ened state, having the hardness of brass, and with a good deal of elasticity and spring in them. The Eureka Tempered Copper Co., of North East, Pa., have succeeded in hardening castings of aluminum in the same way they have hardened copper. Their hardened aluminum castings are on exhibition at the Washington meeting.

As already noted, the most careful and delicate tests have failed to show the slightest hardness given to aluminum by the process of "chilling," as practiced with cast iron. The surface of the metal poured against the cold, hard metal surfaces seems as soft as any other portions of the same aluminum.

Pure aluminum is one of the most ductile and malleable of metals, and can be drawn into the finest wire and rolled to sheets $\frac{1}{1000}$ in. thick. It can also be hammered into foil as thin as gold leaf. The relative malleability of aluminum, as shown by its capacity to beat out well into thin foil, is one of the best tests of the purity of the metal. The less percentage of silicon and iron in the metal, the better and more readily it works up under the beater's hammer. Metal with more than one per cent. impurity will not beat out well into foil.

Pure aluminum is absolutely non-paramagnetic; the same remark practically applies to aluminum with 0·05 per cent. iron in its composition.

A wire of the average lot of 98·52 per cent. aluminum, suspended by nearly torsional chord, exhibited no appreciable polarity.

An ingot of aluminum, containing 0·15 per cent. iron, showed a very faint trace of polarity; with two per cent. iron the polarity was distinct and very decidedly marked.

All commercially pure aluminum sold by the Pittsburg Reduction Co. contains less than 0·20 per cent. iron, much of it running as low as 0·04 per cent. iron. For this reason, aluminum will answer very well for compass boxes or cases for electrical apparatus, where non-magnetic properties are desirable. There are very few commercial metals not chemically pure containing as little iron as does aluminum; certainly all of the brasses, bronzes, or German silver contain a larger percentage of iron.

STRENGTH OF ALUMINUM.

The tensile, crushing, and transverse strength of aluminum varies very considerably with the varying conditions of hardness due to the cold working; also with the amount of work that has been put upon the metal, the character of the section, etc., as will be shown by the accompanying tables of tests, selected from very many as averages of what the metal will stand. The flow of aluminum under tensile tests is very local; the percentage of elongation reducing very rapidly as it is calculated in increasing lengths from point of fracture.

From the above results as averages, we submit the following table of what we believe will be found to be average tensile and compression tests of commercially pure aluminum of composition, varying in each constituent, as follows:

Aluminum	from 97 to 99	per cent.
Silicon, graphitic	from 0·10 to 1·00	"
Silicon combined	from 0·90 to 2·80	"
Iron	from 0·04 to 0·20	"
Elastic limit per sq. in. in tension—castings	6,500	pounds.
" " " sheet	12,000	"
" " " wire	16,000	"
" " " bar	14,000	"
Ultimate strength per sq. in. in tension—castings	15,000	"
" " " sheet	24,000	"
" " " wire	30,000	"
" " " bars	26,000	"
Percentage of reduction of area in tension—castings	15	per cent.
" " " " sheet	35	"
" " " " wire	60	"
" " " " bars	40	"
The modulus of elasticity of aluminum in—castings is about	12,000,000	
The modulus of elasticity of aluminum in—sheets is about	13,000,000	
The modulus of elasticity of aluminum in—drawn wire is about	19,000,000	
Plastic limit per sq. in. under compression in cylinders with length twice the diameter	3,500 lb.	
Ultimate strength per sq. in. under compression in cylinders with length twice the diameter	13,000 "	

Taking the tensile strength of aluminum in relation to its weight, it is as strong as steel of 80,000 lb. per sq. in. ultimate strength. Comparative results in this way are tabulated below as taken from Richards' work on "Aluminum."

	Weight of 1 cubic ft. in lb.	Tensile strength per sq. in	Length of a bar able to support its weight in ft.
Cast iron	444	16,500	535
Ordinary bronze	525	36,0 0	9,893
Wrought iron	480	50,000	15,000
Hard structural steel	490	78,000	23,040
Aluminum	168	26,000	23,040

Mierzinski is quoted from *Dingler's Magazine* as giving the following results of tensile tests of aluminum wire:

Diameter. Millim.	—Tens. strength; gram.— 1st trial.	2d trial.	Mean.	—Tenacity— Kilos. per sq. millim.	Lb. per sq. in.
0·235	661	653	657	12,975	18,360
0·306	524	508	516	12,255	17,427
0·180	307	311	309	12,700	18,059
0·145	246	252	249	11,845	16,844

Wire of the aluminum made by the Pittsburg Reduction Co., however, has given much higher results.

Aluminum when pure is a very sonorous metal; bars of it suspended by fine wire, when struck, give a fine, clear, bell-like sound. The proper shapes for bells have not yet been devised, as bells of ordinary shapes do not give as good sound as do ingots of the metal.

CONDUCTIVITY AND ELECTRO-POSITIVENESS.

In the electro-chemical series, aluminum is ordinarily placed near the positive end, being under most circumstances more positive than almost all the other metals, and only less positive than metals of the alkalies and alkaline earths. That is, in most separations of aluminum by electrolysis it is charged with positive electricity, and separates out at the negative pole. This arrangement, however, is only approximate. Under some circumstances, aluminum is electro-positive to sodium, as it reduced sodium when treated with its oxide or carbonate; again, it is electro-negative to iron, as iron reduces aluminum from its sulphide.

TABLE OF TENSILE AND COMPRESSION TESTS OF ALUMINUM IN VARIOUS SHAPES.

Size, shape and condition of the aluminum.	Elastic limit, lb. per sq. in. tension.	Ultimate strength, lb. per sq. in. in tension.	Percentage of reduction of area in tension.	Estimated safe unit strain per sq. in. in tension.	Original size of specimens used in compression.	After failure, size of specimens used in compression.	Elastic limit per sq. in. in compression.	Ultimate strength per sq. in. in compression.
Metal of from 97 per cent. to 98·50 per cent. aluminum as cast	6,132	15,640	8·00	3,000	1 in. high × 0·5 in. dia.	0·985 × 0·503	3,565	12,730
Ordinary castings of over ½ in. sectional area								
Same annealed	6,600	17,000	15·00	3,500	"	0·975 × 0·506	3,087	10,185
Same lot of casting hardened by drop forging	10,000	24,000	18·00	3,000	"	0·965 × 0·508	4,583	15,275
Aluminum rolled bars left hard	16,000	32,500	42·00	6,000	1¼ in. high × ¾ in. dia.	1·459 × 0·760	2,293	9,064
Same annealed	13,870	25,000	49·11	6,000	"	1·468 × 0·756	2,043	6,800
Aluminum hammered bars left hard	14,630	24,120	35·14	5,500	"	2·91 × 1·52	5,650	11,320
Same annealed	14,000	22,000	43·00	5,500	"	2·92 × 1·519	5,094	11,320
Aluminum wire from ⅛ in. to 1-16 in. diameter as drawn	12,000	24,570	58·46	4,500				
Same annealed	10,870	22,830	65·57	4,500				
Aluminum wire No. 14 to No. 20 B. & S. gauge as drawn								
Aluminum wire No. 20 to No. 40 B. & S. gauge as drawn								
Same annealed								
Aluminum plates to ¼ in. thick as rolled	9,800	22,740	12·40	4,000				
Same annealed	8,500	17,740	13·73	4,000				
Aluminum plates No. 8 to No. 20 B. & S. as rolled	12,500	25,000	35·50	4,500				
Same annealed	10,700	21,070	39·00	4,500				
Aluminum sheets No. 20 to No. 30 B. & S. as rolled	13,500	27,500	40·00	4,500				
Same annealed	11,000	23,000	43·50	4,500				
Metal of 94 per cent. aluminum, 1·5 per cent. iron, and 4·5 per cent. silicon:								
Sheets ⅛ in thick	12,000	29,650	11·00	4,500	1 in. high × ½ in. dia.	0·965 — 0·508	4,800	15,275
Castings ¼ in. × 1 in.	10,500	25,550	9·50	4,500				

The attraction of aluminum for oxygen is exceeded by that of very few elements. If this attraction be measured by the amount of heat developed in the combination of aluminum and oxygen, it is about three times that of carbon for oxygen, as the amounts of heat produced by equivalents of aluminum and carbon in combining with oxygen are approximately as three to one. ($C+O_2$ gives 96,000 units of heat; Al_2O_3 gives 388,000 units of heat; C=1 equivalent carbon, Al=1⅓ equivalents oxygen.)

The powerful attraction of aluminum for oxygen is turned to practical account in the use of aluminum to remove oxygen from molten steel.

In its behavior with most chemical reagents at ordinary temperatures, aluminum resembles platinum and gold. It is like carbon and silicon, which are highly electro-positive at high temperatures, but electro-negative at low. Under some circumstances, as in nitric acid, aluminum is as electro-negative as platinum or carbon. It is suggested that at low temperatures the atoms of aluminum are combined with each other so as to render the metal inert. If its full chemical affinities were exhibited at low temperatures, it would be as easily oxidized by acid and water as metallic sodium.

Mr. C. F. McGee, of the University of Michigan, has determined the electrical resistance of specimens of aluminum of the "average lot 98·52 per cent. metal" with the following results:

Specimens used.	Diameter in in.	Resistance in legal ohms of 1 yd. at 14° C.=57° F.	at 76°C.=170°F.
Unannealed Al wire	0·0325	0·05749	0·07202
Annealed Al wire	0·0325	0·05484	0·06923
Pure copper wire has the following resistance	0·0325	0·0315	0·0387

We find the thermal conductivity is very nearly inversely as its electrical resistance, for unannealed aluminum wire at 14° C. has a conductivity of 17, where copper has the thermal conductivity of 32, the rates being as 1 is to 1·88. Confirmatory accurate determinations are now being made at the University of Michigan, by Prof. Carhart, which we hope to embody in the final revision of the text of this paper.

ACTION OF IMPURITIES.

As stated under the head of "Purity of Aluminum," silicon and iron form the bulk of the impurities, and these two elements will be treated first.

Silicon hardens aluminum considerably, increases its tensile strength without materially decreasing its ductility; it, however, very materially decreases its malleability, takes away its capacity of taking a fine polish, and, much more important, prevents its retaining whatever polish it has received. Silicon in aluminum oxidizes by action of the atmosphere or of moisture, and if present in proportion of over three per cent., very soon coats the metal with a dull gray and unsightly tarnish.

For some purposes where harder surfaces are required than is given by pure aluminum, and where the surface can be lacquered or otherwise coated to protect it from oxidation, the alloy, say six to eight per cent. of silicon, which can readily be made, can be used with advantage; but in all ordinary work to which aluminum is placed, the purer the metal from silicon, the better. These remarks apply to the ordinary ways in which we find silicon, a large portion of which exists in the graphitoidal form. Whether the influence of the amorphus silicon, could it be placed in the metal alone free of graphitoidal silicon, would give the advantageous hardness without the tarnishing qualities, is an interesting question not yet ascertained.

Iron in small percentages as an impurity of aluminum hardens it, but, of course, adds to its specific gravity and renders it magnetic. It also decreases the malleability of the metal, and, like silicon, detracts from the capacity of the metal to take a fine polish or to retain whatever polish it is at first susceptible of, although the alloy does not tarnish as rapidly as does the siliconized metal. For some purposes where a harder and stouter alloy is wanted, a proportion of from six to ten parts of iron works advantageously.

W. J. Keep has pointed out the curious fact that the alloy of 50 per cent. iron and 50 per cent. aluminum, although melted together and seemingly forming a true alloy in the pot and in the metal as first cast, seems to entirely lose its power of cohesion, and crumbles down to a powder in the course of a little while, each grain of this powder seeming to contain equal parts of aluminum and iron.

Copper sometimes becomes an accidental impurity of commercially pure aluminum in proportions up to perhaps one-half per cent.; in such small percentages its influence is hardly noticeable in any of the properties of the metal so far as has come to our notice. In large proportions, up to 10 per cent. of copper with the aluminum, the metal can readily and advantageously be alloyed, especially for casting where hardness of surface is required. It takes away the peculiar polish of aluminum, and the fine gloss and peculiar color of cast aluminum; at the same time it adds hardness and decreases the shrinkage of castings, and for many purposes can be used advantageously. It has the disadvantage of adding materially to the specific gravity of the metal.

Carbon only unites with aluminum under very high and continued heat, and then only in proportions not exceeding three per cent. Wherever it is found associated with aluminum, the metal is brittle and porous and friable.

Both Deville and Fremy say that under ordinary temperatures aluminum and sulphur do not unite or act on each other. Indeed, Deville says aluminum may be heated in a glass tube to a red heat, in vapor of sulphur, without altering the metal. However, at very high temperatures, aluminum and sulphur do combine to form a composition of Al_2S_3. Ordinary aluminum of commerce is entirely free from sulphur.

Lead is found as an accidental impurity of aluminum, in proportions up to one-quarter of one per cent. In small proportions, so far as yet determined, it has no appreciable action upon the properties of aluminum. In larger proportions, lead does not alloy with aluminum, and no homogeneous alloy, or even mixture of the two metals, can easily be obtained.

Antimony does not unite with aluminum to form any homogeneous alloy.

Chromium unites with aluminum readily, hardening it and adding to its tensile strength. An addition of two or three per cent. of chromium improves it for many purposes, although, as in the case of other impurities, it decreases the malleability of the aluminum.

Tungsten unites with aluminum, hardening the metal, but not giving any very useful alloys.

Platinum unites with aluminum readily. It, however, does not seem to give any advantageous alloys. They are brittle and unsound.

Tissier says that silver seems to be the metal most useful to improve aluminum; five per cent. of silver giving to aluminum increased elasticity and hardening without injuring the malleability of the metal. The alloy is susceptible of taking a very fine polish. The silver lowers the melting point of the aluminum considerably. We predict that the alloys of silver and aluminum will have a large use in the arts in the future.

No very valuable alloys of tin and aluminum have been discovered; the tin added to aluminum makes it more brittle, and does not seem to give any valuable properties in return. However, small proportions, up to two per cent., of aluminum added to tin render the tin harder and more elastic without decreasing materially its malleability.

Cadmium unites readily with aluminum, giving fusible alloys which are quite malleable; however, it does not seem to impart strength, but rather weakness to the aluminum.

Bismuth unites with aluminum to form brittle but very fusible alloys.

Nickel unites with aluminum to form brittle alloys in any large proportions; in small percentages, up to three per cent. of nickel, its influence is to harden aluminum without seriously increasing the malleability or ductility of the metal.

An alloy of 70 per cent. of copper, 23 per cent. of nickel, and 7 per cent. of aluminum has a fine yellow color and takes a high polish.

Zinc forms alloys readily with aluminum which are very brittle and highly crystalline.

The best solder yet obtained for aluminum is this alloy of zinc, using Venetian turpentine with it as a flux. Unfortunately, it will not flow well, nor are the soldered surfaces capable of withstanding hard usage.

Antimony does not unite with aluminum to form homogeneous alloys.

PRACTICAL HINTS.

Dipping and Pickling.—Remove the dirt and grease from the plates by dipping in benzine. To whiten the metal, leaving on the surface a beautiful white mat, the sheet should be first dipped in a strong solution of caustic potash. This solution should then be dipped in a mixture of concentrated acids, two parts nitric acid; then in a solution of undiluted nitric acid; then in a mixture of vinegar and water, equal parts; then washed thoroughly in water, and dried as usual in hot sawdust.

To Polish.—Use a fine polishing composition, or rouge or tripoli, and a sheep skin or chamois skin buff, although it is often polished with an ordinary rag buff.

TABLE OF TENSILE TESTS OF IRON AND STEEL CONTAINING ALUMINUM.

Character of material tested.	Elastic limit per sq. in.	Tensile strength per sq. in.	Per cent. elongation in 8 in.	Per cent. reduction of area.	Character of fracture	Analysis. Per cent. of aluminum.	Per cent. of carbon.	Per cent. of manganese.	Per cent. of silicon.	Per cent. of phosphorus.
	Lbs.	Lbs.								
All iron muck bar, rolled at Union Mills (Carnegie, Phipps, & Co., Ltd.)	27,300	46,500	28·0	36·08	Fibrous.					
Three parts all iron, with two parts aluminum muck	26,800	49,000	29·25	40·32	"					
All aluminum muck	29,500	55,300	14·0	22·56	"					
Four parts all iron, with one part aluminum muck	28,510	49,190	29·5	37·34	"					
O. H. steel, with one-tenth of one per cent. aluminum, ⅜ in. thick plate	40,250	58,590	30·10	62·82	Silky cup.	0·04	0·12	0·41	0·02	0·05
O. H. steel, with one-tenth of one per cent. aluminum, 1 in. thick plate	47,150	63,860	25·30	52·10	Silky.	0·07	0·16	0·48	0·03	0·03
O. H. steel, with one-tenth of one per cent. aluminum, 2 in. thick bar steel	46,200	63,750	26·10	47·9	"	0·08	0·16	0·39	0·02	0·05
O. H. steel, with one-tenth of one per cent. aluminum, 2 in. thick bar steel	45,980	67,560	29·20	54·8	"	0·07	0·15	0·55	0·04	0·05

For fine work use a mixture of equal parts, by weight, of olive oil and rum, made into an emulsion by being well shaken together in a bottle. The polishing stone is dipped in this liquid, and the metal is polished, without using, however, too much pressure.

Aluminum may be easily ground by using olive oil and pumice.

The surface of aluminum treated with varnish of four parts oil of turpentine to one of stearic acid, or with a mixture of olive oil and rum shaken into an emulsion, allows an engraving tool to work on aluminum as on pure copper.

For Burnishing.—Use a bloodstone or steel burnisher. For hand burnishing, use either kerosene oil or a solution composed of two tablespoonfuls of ground borax dissolved in about a quart of hot water, with a few drops of ammonia added.

For Lathe Work.—The burnisher should wear upon the fingers of his left hand a piece of Canton flannel, keeping it soaked with kerosene, and bringing it in contact with the metal, supplying a constant lubricant. Very fine effects can be produced by first burnishing or polishing the metal, and then stamping it in polished dies, showing unpolished figures in relief.

Scratch Brushing.—Polish or burnish the surface and then use a fine steel scratch brush. A very fine finish is attained by rubbing with ground pumice stone and water. In spinning aluminum, plenty of oil should be used to prevent the clogging of the tool, to make it cut smooth in the turning and to assist in the spinning.

To Solder the Metal.—Soldering the metal in large surfaces has not been successfully accomplished up to the present. Small surfaces of the metal can be readily soldered by the use of pure zinc and Venetian turpentine. Place the solder upon the metal, with Venetian turpentine, and heat gently with a blowpipe until the solder is melted. It will then be found to have fixed itself firmly to the aluminum. The trouble with this, as with other solders, is that it will not flow on the metal. Therefore, large surfaces are not easily soldered.

Cold-Rolling Aluminum.—Upon rolls designed for cold-rolling hard crucible steel, it has been found possible to reduce aluminum through the same sections as hard steel; the aluminum required, on the average, five annealings, where the steel required three, to satisfactorily withstand the same work.

ALLOYS OF ALUMINUM AND COPPER.

Ten per cent. aluminum with 90 per cent. copper (called 10 per cent. aluminum bronze), rolled into plates, has an elastic limit of 70,000 to 80,000 lb. per sq. in., a tensile strength of from 100,000 to 120,000 lb. per sq. in., a reduction of area of from 20 to 40 per cent., with an elongation of from 5 to 10 per cent. in 8 in. The metal has a beautiful yellow color and is susceptible of taking a fine polish.

One great advantage of the metal is its freedom from corrosion from the action of the air, either moist or dry, or water upon it. Its specific gravity in castings is about 7·64, and in rolled sheets about 7·89. Its modulus of elasticity is about 18,000,000 lb. In castings, it has a tensile strength of between 70,000 and 80,000 lb. sq. in., with a reduction of area of about 20 per cent.

Compression tests upon cylinders of 10 per cent. aluminum bronze, ¾ in. diameter and 2 in. long, gave an ultimate compressive strength of 160,000 lb. per sq. in., the specimens being shortened by ¼ in. A similar piece of 5 per cent. bronze was shortened to 1⅛ in., and gave an ultimate compressive strength of 153,000 lb. per sq. in.

Five per cent. aluminum bronze in tension has an elastic limit of about 50,000 lb. per sq. in., a tensile strength of about 70,000 lb. per sq. in., a reduction of area of from 30 to 50 per cent. Its specific gravity is from 8·20 to 8·30. Two and one-half per cent. aluminum bronze has a specific gravity of 8·6.

The melting point of 10 per cent. aluminum bronze is about 1,700° Fahr., a little higher than that of ordinary brass. The metal shrinks a little less than ⅛ in. to the foot, or a little less than ordinary brass. It solidifies very rapidly from the molten condition, and it is necessary to pour it very quickly. The feed gates should be made large enough to prevent the metal freezing. Hot baked sand moulds should be used for casting. Precaution should be taken also to prevent oxidation of the metal, for without it the oxide is carried into the metal, which prevents its rolling into sheets.

It is well also to "bottom pour" the metal into the mould—that is, to cast the metal into a hot ladle having a nozzle in the bottom in direct connection with the gate of the casting, allowing the metal to settle so that the oxide and dross shall come to the surface, in this way preventing its entering into the casting below. The surface of the molten bath should be kept covered with powdered charcoal.

It is also advantageous to keep the bath covered with a flux in some cases, although the disadvantage of this is that the flux is apt to cut the sides of the pot and add silicon to the metal. It is well to tap the metal in an inert atmosphere (casting in a cloud of smoke or the like), to prevent the oxidation from the air in the mould attacking the metal.

Aluminum bronze is an extremely dense, close metal. It can be worked at a bright red heat as easily as can wrought iron. In this respect it differs from all other forms of bronze, which are red-short at a red heat. The fact that aluminum bronze is malleable at a red heat and stands this temperature without change makes it especially adaptable for blast furnace tuyeres. The metal can be hardened to a considerable extent by working without annealing. To anneal aluminum bronze, heat to a dull red heat and permit it to cool gradually.

The alloy of aluminum and copper does not volatilize at any ordinary temperatures used in fusing it, and consequently it can be frequently remelted without any appreciable change in the chemical constituents of the metal.

This has great advantages in the economic use of the metal, as the scrap in casting or rolling can be readily remelted into ingots of the same quality of metal.

Aluminum bronze can be brazed as well as any other metal, using as a solder: Zinc, 50 per cent.; copper, 50 per cent.; using ¼ of the solder and ¾ borax and cryolite in equal parts.

With pure aluminum as now manufactured by the Pittsburg Reduction Company, very pure aluminum bronze alloys can readily be made, the impurities in the aluminum being reduced to one-tenth their amount on being diluted with pure electrolytic Lake copper.

The following are some of the analyses of aluminum bronzes lately made by the Pittsburg Reduction Company and by the Scoville Manufacturing Company:

Kinds of alloys.	Per cent. aluminum.	Per cent. copper.	Per cent. graphitoidal silicon.	Per cent. non-graphitoidal silicon.	Per cent. iron.	Specific gravity.
10 per cent. bronze casting made December 5, 1889	9·20	90·0	0·117	0·370	0·077	7·69
5 per cent. bronze casting made December 5, 1889	4·70	94·84	0·080	0·320	0·060	8·25
2½ per cent. bronze casting made December 5, 1889	2·35	97·29	0·05	0·260	0·050	8·61
10 per cent. bronze casting made at Newhausen	6·32	91·98	0·09	1·090	0·48	8·01

ALLOYS OF ALUMINUM AND IRON.

Aluminum in Wrought Iron.—The influence of aluminum in making wrought iron fusible has been taken advantage of in the well-known Mitis process of making castings of wrought iron.

Aluminum furnished by the Pittsburg Reduction Company has been found to be very advantageous, and is largely used in the manufacture of the Mitis metal.

Aluminum will also increase the tensile strength of wrought iron and improve the fiber, if added either as pure metal or in the form of ferro-aluminum to the molten bath, just before the metal comes to nature in the puddling furnace.

Aluminum in Cast Iron.—The influence of aluminum in cast iron is to turn the combined carbon to graphite—that is, to make the white iron gray, and also to close the texture of the metal. (W. J. Keep.)

It makes the metal ordinarily more fluid, and it also makes it susceptible of taking a better polish and retaining it free from oxidation. Aluminum will also increase the tensile strength of many grades of cast iron, and aids in obtaining sound castings free from blow holes.

It has been used in preparations from one-tenth of one per cent. to 2 per cent. with good results, with various grades of iron.

Aluminum in Steel.—The influence of aluminum in steel of high carbon is to turn the combined carbon into graphite, and destroy the hardening action of the carbon in tool steel. Aluminum in this sense softens steel. In structural steel of 0·20 per cent. carbon, a small amount of aluminum, up to 1 per cent., increases the tensile strength without to any great degree decreasing the ductility. By its aid a higher tensile strength can be obtained in thick sections of steel which have been subjected to but little work than can be otherwise obtained; although aluminum with considerable quantities of graphitoidal silicon have been added to steel, no graphitoidal silicon has been found in the steel afterward, it being all found in the amorphous or combined state in the resulting steel. The influence of aluminum is also to lower the melting power of the steel, and in this way make it more fluid. It also makes the ingots of steel more solid and free from blow holes. It can be most advantageously used in proportions of from one-tenth of one per cent. up to 3 per cent. of aluminum.

METHODS OF ANALYSIS OF ALUMINUM AND ITS ALLOYS.

[Under this head the authors give a full description of the methods employed by the Pittsburg Testing Laboratory, chemists to the Pittsburg Reduction Company, in analyzing aluminum and its various alloys. The tests for iron, silicon, copper, calcium, alkalies, etc., are given in full. For the determination of aluminum when present in minute quantities in iron and steel, which has always been a most difficult problem, the method given by Andrew A. Blair, in his work on the "Chemical Analysis of Iron," is recommended as correct, though very tedious, requiring several days to perform. The method of Jno. E. Stead, as described in the *Journal of the Society of Chemical Industry*, December 31, 1889, is given in full, and is reported as having given very satisfactory results. It can be made in twelve hours.]

METHODS OF PREPARATION OF ALUMINA, THE ORE OF ALUMINUM.

As considerable inquiry has been made as to the ore from which aluminum is made, it may be well to state here that aluminum is now being manufactured from the oxide, alumina, which is purified chemically from silica and iron, from the native bauxite mineral. Bauxite is found in considerable quantities, and fully as pure in quality as the best foreign mineral, in the States of North Carolina and Georgia, and there are vast deposits of it in Ireland and northern France. The average composition of bauxite is about as follows, as given by Dana, at the Pittsburg Testing Laboratory:

	Al_2O_3.	SiO_2.	Fe_2O_3.	H_2O.	TeO_2.	$CaCo_3$.	Authority.
White from Be'x, France	58·1	21·7	3·00	14·0	3·20	trace.	Dana.
Br'sh red from Revest, France	57·6	2·80	25·3	10·80	3·10	0·40	"
Oolitic from Allamt, France	55·4	4·80	24·8	11·60	3·20	0·20	"

The two methods of purification of bauxite are as follows:

Bauxite, or a rich clay, chosen as free from iron as possible, is roasted at a low red heat, and afterward treated with sulphuric acid, which combines with the alumina present, forming sulphur or alumina. This is readily dissolved by water, leaving the great bulk of silica and iron behind. The solution of sulphate of alumina is allowed to settle, the supernatant liquid siphoned off into an evaporator tank and evaporated to dryness. The dry sulphate of alumina is calcined at a red heat, driving off the sulphuric acid, leaving as a residue anhydrous alumina. This calcination seems to be as easy as the calcination of alumina hydrate, and there appears to be no difficulty in condensing the volatilized sulphuric acid, which can be used over again. This process is easier, on a laboratory scale, than the soda carbonate method, which is about as follows:

Bauxite is fused with carbonite of soda, in a reverberatory furnace. The fused mass is lixiviated with water, which dissolves aluminate of soda, which is decanted off. The solution of aluminate of soda is decomposed by carbonic acid gas, which forms carbonate of soda, which remains in solution, and the alumina hydrate is precipitated. This alumina hydrate is afterward washed repeatedly with water, dried, and calcined at a red heat for a considerable time, which forms anhydrous alumina.

THE AMŒBA—A LONG-LIVED ANIMALCULE.

THE particle of living matter which crawls over the water weeds, and lives amid decaying matter of all kinds, forms, in its way, a study of most important nature. This particle is microscopic in size. It may average in diameter the one four-hundredth part of an inch or thereabout, when it gives you a chance of measuring it at all. It is known as the *Amœba*, a word derived from the Greek, and signifying "change." Well is it so named, for it passes its existence in flowing from one shape to another. It is ever in movement, save when it lights upon its bad times, or when certain developmental changes are about to occur in its history. Now it is like some solitary island, with capes, headlands, and promontories jutting out in a sea of its own; then it alters to a rounded shape; and then again pushes out its body into processes and prolongations; and thus lives and moves through the perpetual alterations of its form. Imagine a speck of white of egg to be endowed with a power of independent movement; further, suppose that this living jelly-speck, by pushing out the substance of its body into processes, seized food particles and engulfed them; and finally, assume that, by thus shifting its body shape perpetually, it was able to move through the water or over any surface on which it might happen to reside—and you have a picture, bare in outline, it is true, but substantially correct, of the amœba animalcule.

Now, the amœba (which has always formed a type of the lowest animal life), in its way, presents us with certain problems of matter and life which are, indeed, very far from solution. To begin with, it is a speck of protoplasm, as we have seen, and it exhibits life in its simplest guise—yet the puzzle of the animalcule's vitality is, to my mind, as great as is that of the man. Nay, it is even a deeper problem, that of the lower animal's life. For your man has organs wherewith to live. He is a complex machine, which lives through the operation of the machinery wherewith it is provided. But your amœba is a piece of vital mechanism which lives literally without aught to live by or with, save the apparently structureless living matter of which it is composed.

A watch goes in virtue of its mechanism, and the man and the watch agree so far in that their actions are performed by the machinery which is characteristic of each. But, while a workless watch is an anomaly of art, it is a reality of nature; and the amœba is a workless watch in the truest sense. Every action is performed by the protoplasm of which its body is built up. One and the same particle of protoplasm seizes food and eats and digests it, moves, and reproduces its like. It is the household of the one servant who performs all the work of the domicile; the higher animal is the house of many servants, each performing his or her share of the duties which fall to be discharged in the maintenance of the family's life. Yet, curiously enough, extremes meet here as elsewhere.

If you ask me what it is that performs all the duties of the complex body, I reply, the living cells. As I described them a week or two ago in these pages, I styled

them the workers of the body. Each cell is a little speck of living protoplasm; and if it be true that such cells are the real workers of the human estate, then it becomes clear that the one great difference between man's bodily labor and that of the amœba is that, while the former engages many bits of protoplasm to do his work, the animalcule's duties are performed, each and all, by the same speck of living matter.

There is, however, another trait of amœba character which is worth thinking over. When new amœbas are to be produced, we see the body of the original animalcule (if so we may term it) simply dividing into two or more parts. Each half passing away on its own part begins life as a new animalcule, and only requires to eat and feed that it may become as big as the parent from which it was derived. That parent, however, is still in existence.

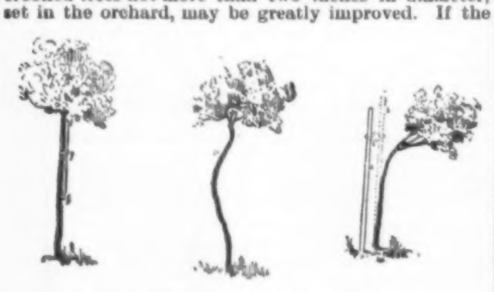
It may give origin, time after time, to many new amœbas by this simple process of division of the body substance, or *fission*, as naturalists name this process—the simplest of all fashions in which an animal can reproduce its kind. Note that there is perfect continuity of matter between the amœba and its progeny thus derived from it, by actual division of the parent substance; and note also that the amœba with which we started may be presumed to have originated in like manner as a detached bit of protoplasm, the offshoot of a previously existing animalcule. The end of this matter is, then, that amœba protoplasm is, *de facto*, an immortal substance. It can never be said to die, since piece by piece it is divided, but only to increase in size as the new animalcules, and in its turn to hand on the same veritable protoplasm to fresh generations.

This is what Dr. Weismann terms animal immortality of the purest kind. Our amœba never passes out of existence, for its protoplasm will really be handed on and on through all succeeding ages, as it has come down to us intact from the æons of the past. True, there is always a making of new protoplasm. Animalcules and men alike ingest food, and convert this food into themselves, which is only another way of saying that they make fresh protoplasm to make up for that which has been lost or worn away in the act of living. Yet there is continuity to be seen notwithstanding this consideration; and the animalcule, in that it hands on its veritable substance to form the next generation, must be held to be as near the immortals in a physical sense as even Dr. Faust could have wished; while like that mediæval practitioner, the animalcules certainly enjoy a perennial rejuvenescence, and perpetually renew their youth.

How comes it, then, one may ask, that in higher animals this physical continuity and immortality of substance is not represented? It is represented, in one sense, whenever an animal or plant hands on the successors it has produced to fight the battle of life. Inheritance—mere vital succession of progeny to parent—is a kind of perpetuation of substance, seen in the very features we inherit from our ancestors. The animalcule, however, shows this kind of perennial vitality most plainly, because in its case we can see how the actual substance of its body is separated to form the new being. And if we finally ask, "Why should the death of the individual be common in higher life when it is apparently not so in lower existence?" I can only answer (adopting a familiar suggestion) that in the higher animal or plant, when the task of reproducing its like is laid upon its shoulders, death intervenes. In other words, there is a clearing away among higher forms of the old stock, and a placing of new stock to carry on the work of the species as the result of reproduction. Death is thus the gate of life in a physiological sense. The animalcule never dies, but trudges on its existence unchanged and unchanging. Your higher organism, requiring greater vitality, gains such increased and fuller life from the sacrifice of the parent-existence; and death is the penalty we pay for advance. On "our dead selves," physically as well as morally, we "rise to higher things."—*Andrew Wilson, in the Illustrated London News.*

MAKING THE CROOKED STRAIGHT.

MANY fruit trees as they come from the nursery have crooked trunks, and if these are not made straight, they are liable to grow into deformed trees. The proper time for doing this work is when the trees have been transplanted, but it is too often neglected, yet crooked trees not more than two inches in diameter, set in the orchard, may be greatly improved. If the

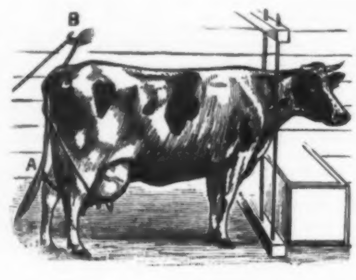


trunk simply leans to one side in a gradual curve, drive a strong stake into the ground about 20 inches from the tree; connect the top of this with the tree near the branches, drawing the tree so that it will occupy an upright position, as indicated by the dotted line, *b*, in the cut. A band of wire, leather, or cloth can be used, but the place where it comes in contact with the tree should be padded with cloth or a twist of hay to prevent injury to the bark. When a bad crook occurs along the trunk, as shown in the middle figure, instead of using two stakes, simply follow the plan shown at the left hand figure. A strip of seasoned wood about one inch square, or large enough not to bend readily, and long enough to span the crook, is laid on a few thicknesses of cloth where it touches the tree; the crooked portion is then pressed up close to the stick, and retained in position by a leather band. One season's growth is usually sufficient to correct any of the irregularities named, and then the guide may be wholly removed.

Remember all these corrections of malformations will add to the tree's beauty as long as it stands—in many cases for several generations.—*Rural New-Yorker.*

KICKING COWS.

TAKE a rope 10 or 12 feet long, fasten it securely about 5 feet 3 inches from the stanchion and 21 inches from the floor, as shown at A. After fastening the cow in the stanchion, take the free end of the rope, pass it between her hind legs, draw it up in front of her right leg, and passing it around behind her, draw it over a hook, or, better, a flange pulley, as shown at B. Have a loop in the free end of the rope; draw tight, and fasten it by running a pin through the loop. To release the cow, all you have to do is to draw the pin and throw the rope off the hook or pulley, B. It is impossible for the cow to kick, move about, or injure



herself in the least. I have cured the worst kind of kickers with this appliance in a short time. W. F. MARKS.—*Country Gentleman.*

THE CANTALOUPE.

OF the various members of the gourd family, those which interest us generally are the plants which supply our tables with delicacies, of which the cantaloupe has the greatest number of admirers, and, in the estimation of some, it has no equal among our summer fruits. To constitute perfection, the fruit should be removed from the vine shortly before it is ripe; it should be washed with soap and cold water, then dried in a soft towel, and set to ripen in a dry place. A cantaloupe that before washing smells like a potato will in a few hours begin to give out an inviting perfume, and when this odor has reached its proper measure and character is the time to cut the melon.

My own ideal melon is of the size and form of a large ostrich egg, with a thin, finely netted rind, thick, grass green flesh, a small seed cavity, and a sweet, aromatic flavor. Some fifty years or more ago there was introduced into this market a small, green-fleshed cantaloupe known as the "Center melon," which for a time excelled in richness of flavor all of its competitors. It was flat in form, grooved and finely netted; but it was too little to suit the ideas of the trucker, and therefore had to be made larger by hybridization with other flat varieties of greater diameter but inferior flavor. This Center melon was the progenitor of the Jenny Lind variety, named about 1846; but where it came from no one now appears to know. I am inclined, however, to believe that it originated in the East, and possibly in the table land of Armenia, where netted, green-fleshed melons are produced in abundance, some of which are flat, and where the same perfect flavor is to be met with. These Armenian melons belong to a hardy race, are quite productive in our climate, and can stand it quite as well as any of our own kinds; they are as yet entirely unknown to our seedsmen, but have been grown under the severe test of the season of 1889. In form they are flat, globular or oval, the last being seven inches long, and all are fine-grained, thin-rinded, green-fleshed and closely netted, the last an unusual feature in our own varieties last year. This oval cantaloupe has come nearer to my ideal than any one I have yet tested, and I hope to give it a better trial this coming summer. As Oriental seeds always come mixed in the packages, it will take time to separate the varieties by selection. As I have discovered Erzeroum, in Armenia, to be a great melon center for both cantaloupes and watermelons that are calculated to stand our hot summers, it is to be hoped that our enterprising seedsmen will take steps to secure a full line of seeds, and particularly since my twenty-six kinds of watermelon seeds were all lost in the wet ground.

The cantaloupe has largely multiplied in its varieties in our country of latter years, and we have now those that are white-fleshed, yellow-fleshed, red-fleshed, and salmon-fleshed. We have also netted, toad-marked and smooth fruits, with green, yellow and whitish rinds. Attempts have been made to grow the winter varieties of Naples and Malta, which may be ripened from Christmas to Easter, but as yet with no encouragement. The large green melon of Naples is the best and grows in boggy land, but has thus far failed when planted in the same form of soil in Florida, under my directions.

In size the cantaloupe varies as much as in quality, and the extremes of weight are a few ounces and fifty-two pounds, the largest being coarse-grained and somewhat fibrous in texture. Up to twenty or twenty-five pounds fine-grained fruits are produced, especially of the green-fleshed varieties. The largest imported kind was introduced from Portugal, and of native varieties was brought recently from Colorado, both at their maximum weighing over fifty pounds, and being as large as very large watermelons. For a combination of large size and fine quality, perhaps no imported variety ever equaled the Persian melon grown for many years in the vicinity of Washington City, under the name of the Hunter cantaloupe, a long, golden, closely netted fruit, with green flesh, reaching twenty inches in length and a weight of twenty-five pounds. This must not be confounded with the Casaba or Smyrna melon, often erroneously called Persian, the seeds of which were sent to the United States by Dr. Goodell, now of Philadelphia, on several occasions when residing in Constantinople.

Persia is a land of melons from which we have had, as far as known to me, but four varieties of cantaloupe, two of which are still produced, and no watermelon. Who now grows the Ispahan cantaloupe of the late Bayard Taylor, or the Persian melon of our late president, Mr. Mitchell? These may still exist as hybrids; but in their original character they are unknown here. Travelers praise the melons of Persia, write about them and throw the seeds away. Missionaries and American physicians have occupied the garden spots of the land of Ahasuerus for half a century; have sent thousands of letters home, and have often visited their own land in person, but where are the apricots, quinces, melons, and pomegranates of their introduction?

My own cantaloupe tests have been made with seeds from France, the north and south of Italy, Tripoli, Turkey, Turkistan, southern Russia, Russian Georgia, Cappadocia, Armenia, the valley of the Euphrates, Palestine, and Japan. Many melons that are excellent in France and northern Italy will not grow in our climate on account of the heat; those from the land south of Naples do fairly well, but their quality for the table is inferior. The toad-marked melons of northeastern Italy under repeated tests have always failed, and so have our netted varieties in the cooler parts of that peninsula. Worms and bugs appear to delight in the flavor of the delicate foreign vines, and if the plants should in part escape their ravages, their leaves droop under the sun, and the fruit is not worth cutting. There is something very peculiar in the effects of soil and climate in the production of growth and flavor that we cannot understand. That seeds from cool countries should fail here, and that those from some hot countries should not, we can understand; but why varieties from other hot countries, having a good soil and cold winters, should utterly fail in quality of fruit when it, to a certain degree, grows well, we cannot explain. Of all foreign seeds, I have never seen any that grew so exactly in all respects like our own as those from the world's center, the ancient land of Ararat, now called Armenia.

Cantaloupes may be divided into two classes: one that ripens to the best advantage in the house, and the other on the vine and exposed to the sun. Netted and grooved melons, as a rule, attain their finest flavor in the house, and should be pulled as soon as the green color at the bottom of the grooves has fairly begun to lighten. If a netted melon is pulled a little too soon, it will keep a long time, but never ripen, and some varieties when apparently well matured will only go to decay if separated from the vine; such are not favorite sorts with the trucker, but may be improved by hybridization with such as ripen more readily.

Cold nights, cold, damp ground, and a mild temperature, with very little or too much rain, are all antagonistic to the growth and maturing of our cantaloupes. Cold ground, with in the day a moderately warm sun, will cause a large melon to grow flat at the bottom and very convex at the top; the flesh of the upper part will also be much thicker and better flavored than that of the bottom.

This rule of flavor is a general one, and a generous way to divide a melon it to cut it through the middle of the ground spot, either crosswise or through the stem and flower ends. In seasons like that of last year, melons only become about half netted for want of sun, and are poor in flavor when considered ripe; vast quantities brought to market never ripened. The melons from my Armenian seeds were exceptional in being densely netted.

Although the pollen of a cucumber flower is capable of ruining the flavor of a cantaloupe, it is very rare for a hybrid to be produced. I have seen such, between a cucumber and a Jenny Lind melon, which was a decided curiosity. A noted Palestine cucumber, known as the Mukte's, is produced upon a vine that very closely resembles in leaf and color that of a cantaloupe; still, the fruit is an old variety of cucumber and quite distinct from any of our sorts. The long banana cantaloupe makes a curious hybrid with the Jenny Lind, the product being oval, yellow, almost free from netting, very fragrant, and salmon-fleshed; it has a better flavor than the former, but is quite inferior to the latter.

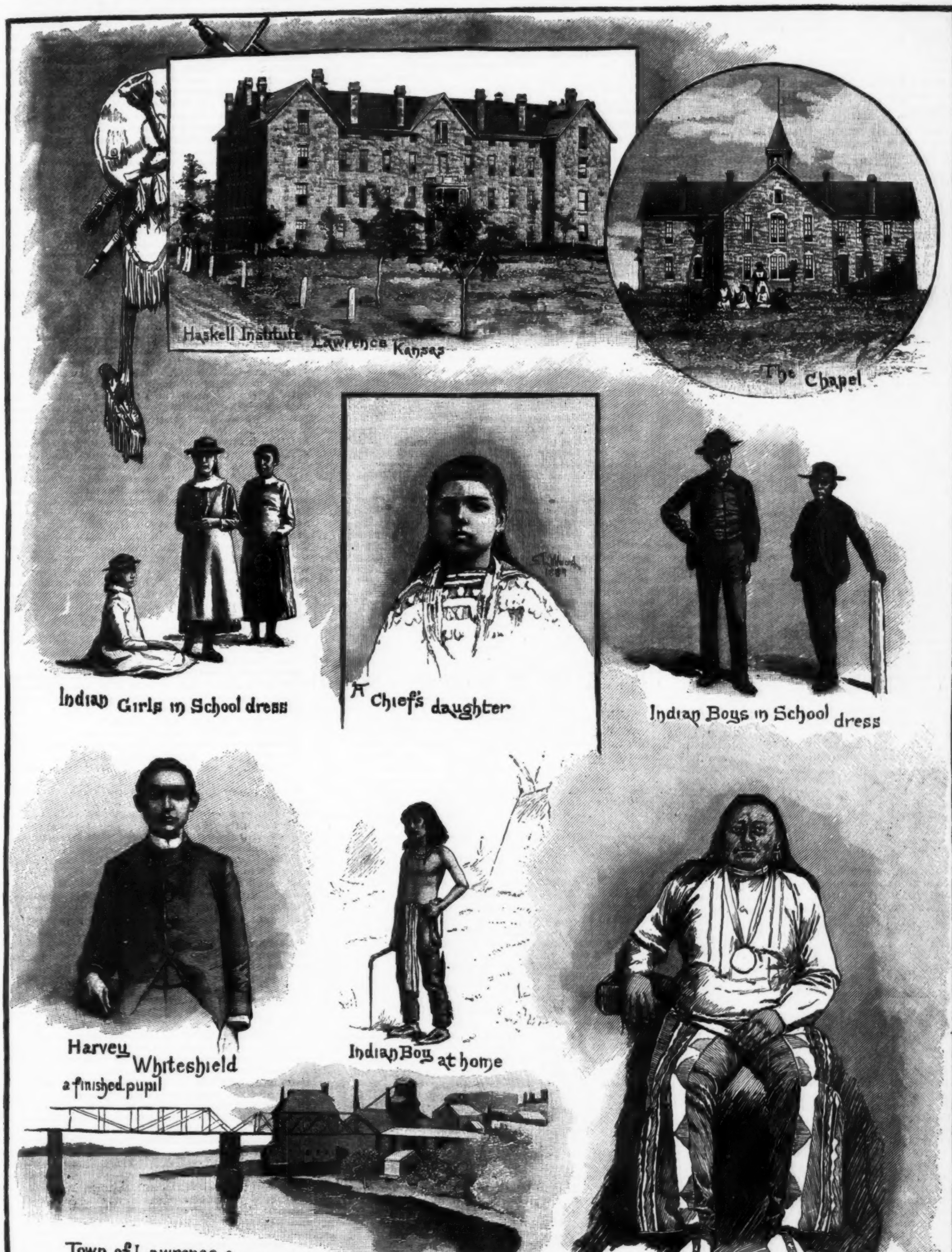
In Armenia there grows a cantaloupe, probably of large size, to judge by the seeds, which is so sensitive to the heat of the sun that the gardeners are in the habit of covering the young melons with earth until they reach a certain size, when they are uncovered; this variety will be tested the coming season in several localities. The seeds are very large and white, much larger than any we have, and resemble those of the curious yellow Cappadocia melon introduced by me several years ago and not now grown; it was long, flat, smooth, and salmon-red fleshed, like the banana cantaloupe in all points except in its shape.

Some years ago a few winter cantaloupes were grown in this latitude, but the measure of success did not encourage the grower to continue the experiment; still, I see no reason why other attempts should not be made.

American visitors to Naples are willing to pay sixty cents for a green melon in winter, and speak of it as wonderfully fine; in fact, it is the finest Neapolitan variety, and ought to be grown in some Southern State, if possible, as a new industry. If the Naples melon will not succeed, the Malta green one should be tried. These melons are put away in the fall before they begin to ripen, and kept in a cool place. When one is to be ripened, it is hung up in the open air in a warm place, in a net or a little bundle of straw, as bottles are sometimes incased for packing. The Naples seeds are very large, but of a form that ought to grow; the dry soil varieties may do better in our country.—*From an Address before the Pennsylvania Horticultural Society, by Dr. Robert P. Harris.*

IN England the rapidly growing use of road coaches for parcel post service arises from the fact that, for short distances, it is more economical to carry parcels by this method than to send them by rail. The railway companies take 55 per cent. of the gross postage for their expenses, which are practically as heavy for short as for long distances, and therefore, up to a certain mileage, the post office authorities state, parcels can be carried with greater economy by road. The parcel post is for the public cheaper for long distances and small parcels, but the railway service is cheaper for larger packages and shorter distances. Between places as far apart as Manchester and Liverpool, parcels above 3 lb. weight go cheaper by rail, and the average for parcels up to 11 lb. is 6½d. by rail and 10½d. by post. But the postal service has the advantage for small parcels, and a large proportion of the parcels are below 3 lb.

THE HASKELL INSTITUTE.



THE HASKELL INSTITUTE, A TRAINING COLLEGE FOR INDIANS, AT LAWRENCE, IN KANSAS.

THE Indian training college, situated two miles south of Lawrence, in Douglas County, Kansas, is called the Haskell Institute, after Mr. Dudley Haskell, one of the representatives of that State in Congress. It is under the control of the United States government.

The inmates are male and female members from all tribes living in the Indian Territory, our correspondent having seen there representatives of twenty-six different tribes. The Cheyennes are the brightest and easiest to teach. Harvey Whiteshield, one of this tribe, and son of the principal chief of the tribe—Chief White Shield—has been five years at the Government Institute at Carlisle, Pennsylvania, also at college at Hanover, in Indiana, and finished at the Haskell Institute. The boys are taught reading, writing, and arithmetic, with carpentry and wagon building and tailoring. The girls learn reading, writing, arithmetic, sewing and cooking. The pupils' uniforms are all made by the boys and girls, under the superintendence of capable teachers. The girls wear pinafores and stuff dresses; the boys, dark jean suits, somewhat similar to the uniform of the United States troops, and soft hats. The idea is to educate the pupils, and teach them useful trades, so as to wean them from their nomadic way of living.

Haskell is one of the foremost colleges of its kind, after Carlisle, in Pennsylvania. It can accommodate over five hundred boys and girls. The town of Lawrence being not a great distance from the Indian Territory, the Indians will let their children go to Haskell, rather than let them go so far as Carlisle. The

college is, in fact, a large boarding school, with a competent staff of male and female teachers. No special form of religion is enforced, but the Indians are partial to the Congregational manner of worship. This is somewhat due to the fine singing always to be heard at the Lawrence Congregational Church. The beneficial effects of the institution of this training college will be seen fully when the majority of the tribes are educated. There is a fine museum of Indian relics attached to the college.—*Illustrated London News.*

HOMEOPATHY: ITS PRESENT RELATIONS TO THE PEOPLE AND TO "THE OLD SCHOOL."*

By WM. TOD HELMUTH, M.D., LL.D., Professor of Surgery, New York.

THE establishment and the enlargement of institutions of learning mark a step forward in the progress of civilization. They indicate an increased demand for the acquirement of knowledge and the necessity for proper facilities for the cultivation of those intellectual forces which in their perfection and wider dissemination must ultimately redound to the nation's glory.

The multiplication of such educational foci is substantial evidence that the material wants of the people have been satisfied (for after all man seeks first to gratify the innate cravings of the body), and that the mind, though christianized, still, as in the days of Plato, is yearning for higher attainments and "something yet to come."

It points, moreover, to the significant fact that the elevated and refining influences of education are not in our times nor in our country confined to the comparatively few, but that these great vehicles for the transmission of knowledge are demanded and will be supported by those who desire to avail themselves of the opportunities thus afforded for the cultivation of that particular branch of knowledge most congenial to each individual taste.

Great universities have always been the pride of great countries; their influences extend to every quarter of the globe wherein their fellows may wander; their libraries (the receptacles of a vast array of the records of the thoughts and acts of great men in all departments of learning and the arts) are open for research and study; their very names give dignity and position to the countries to which they belong, and exert a silent but powerful sway over the destinies of nations. It would scarcely be credited that the influence of one of the first medical schools in existence, founded in the fifteenth century, has extended itself to us through the lapse of hundreds of years, yet such is the fact.

A learned antiquarian scholar as recently as 1886 thus writes: "There is hardly a scrap of proverbial wisdom handed down to us from our ancestors upon the inexhaustible subject of what is wholesome or unwholesome in diet, etc., which may not be traced in one form or another to the *Regimen Sanitatis.*" The reputation it acquired was so great that more than twenty editions appeared in Latin within a century after the invention of printing, of which the earliest was published in 1480. The school of Salernum, from which the work emanated, was perhaps the greatest medical school of the period.†

But when, in addition to the dissemination of knowledge, opportunities are offered in the same institution for the practical application thereof, it must be conceded as a guarantee of the genuineness of such instruction and of the honesty and faith of those who impart it. Our *teaching* is done in the college yonder, our practice is exemplified in this building wherein we are now assembled—a free hospital which through the liberality of Hon. R. P. Flower is open to the poor to-day. Too much cannot be said in praise of those who, having means at their command, employ them for the relief of the misery which, in its Protean forms, afflicts the poor who swarm in great cities.

There is no benefaction so grand, none that has such extended practical influence, none that can render a man's name more revered, than the founding of a free hospital for the poor. It renders him who thus disposes of his wealth not only great while he lives, but when he dies remains a monument to his humanity (which I conceive to be the underlying principle of true Christianity) and to his charity, "which is not puffed up," and which "never faileth."

Dean Swift has said, "There is not anything which contributes more to the reputation of particular persons or to the honor of a nation in general, than in erecting and endowing proper edifices for the reception of those who labor under different kinds of distress. The diseased and unfortunate are thereby delivered from the misery of wanting assistance, and others are delivered from the misery of beholding them."‡ That the donor of this charity may live long to witness the practical results of his generosity, I am sure is the sincere wish of every one here present.

In the face of the fact that there are already three well established and flourishing medical colleges in this metropolis, the necessity for the further enlargement of this one—the palpable advancement of which we now inaugurate—may be questioned, especially by those who, being engrossed in other pursuits, have not reflected upon the subject. There are certain branches of medical science held in common and taught alike in all medical colleges, which are fundamental to the science of medicine. But this "college and hospital" is chartered to teach the two departments of medical learning to which all others are subservient, and without which medicine would be a blank, in a manner entirely different from that pursued by her sister institutions. These branches are therapeutics and materia medica. This institution teaches *homeopathic* therapeutics, which the other colleges ignore, and a materia medica which the other colleges in the main know nothing whatever about. This institution of learning receives the prefix "Homeopathic" because it instructs its matriculants in "Homeopathy," which necessarily implies the indoctrination of its students in a peculiar method of studying and applying the materia medica. *Such instruction cannot be had in any of the old school colleges in this city.*

It is an error, however, of the highest magnitude, to suppose that homeopathy is a perfect system of therapeutics; it is indeed far from it. Not because the law *similia similibus curantur* is not applicable to all cases of curable disease—indeed, for the sake of argument, it may be granted so to be—but it would be absolute nonsense to say that with our present knowledge of drugs it can be universally applied, simply because on the one hand "the knowledge of the physician" is scarcely able to compass the whole of the materia medica, and on the other because the materia medica itself is very far from being complete. That both of these difficulties will be in a measure overcome there is abundant evidence; the first by the increased individual application of the doctor to the study of his cases, the second by the combined action of the school in the perfection of the materia medica. The sooner the "symptomen codex" now so plethoric with symptoms can be reduced to a compact and sound body of facts, the more widely applicable will become the law of cure. This effort is now being made by every homeopathic medical society in the United States. Some of my distinguished colleagues in this college have labored long and earnestly in this important direction, and a strong body of learned men in this country and in Europe are at present working with combined action for the same purpose.

It is not denied by any member of this institution, that there are methods by which disease may be cured, *other* than the homeopathic, but it is claimed that, compared with the present imperfect methods of therapeutics, it is applicable to a greater majority of diseases, and is of more actual service to suffering human beings, than any other system now in use—indeed, it is a matter of very great uncertainty whether there be any other *system* (properly so called) extant. This fact—I mean the absence of any direct and uniform method for the selection of medicines for the cure of disease—is tacitly allowed by the majority and openly declared by a minority of the old school.

As especially bearing upon this matter and another to which allusion will be made hereafter, I desire to quote here the words of Mons. Marchal (de Calvi) from an essay read before the French Academy some years since, and which is truer to-day than at the time of its utterance. He says:

"In medicine, there is not, nor has there been for some time, either *principle*, *faith* or *law*. We build a tower of Babel, or rather we are not so far advanced, for we build *nothing;* we are in a vast plain where a multitude of people pass backward and forward; some carry bricks, others pebbles, others grains of sand, but no one dreams of the *cement;* the foundations of the edifice are not yet laid, and as to the general plan of the work, it is not even sketched. The mass of such labors and facts is enormous; no reader can wade through them; *but no one has any general doctrine.* The most *general doctrine that exists, is the doctrine of homeopathy. This is strange and lamentable—a disgrace to medicine—but such is the fact.*"*

The dominant practice of the old school men (that is when they do not adopt the homeopathic law as their guide, which is very frequently and surreptitiously done nowadays) is derived from the experience of others; but experiences manifestly differ so widely, and are so much under the control of circumstances, that such prescribing must be desultory and uncertain and therefore unscientific; for science is founded upon law. It has been argued that the old adage, "*Experienta docet omnia*" is as true when applied to medicine as to any other conditions of life. It must also be remembered that there is another proverb which reads, "That which is one man's meat is another man's poison;" therefore medicine must be the exception which proves the rule.

My estimation of the true homeopathic physician is that he is one who believes in the law of cure, *similia similibus curantur*, as applicable in the treatment of the majority of curable diseases, *and employs it whenever he can possibly do so*, but he is also one who knows that certain diseases are incurable; that many are occasioned by mechanical causes; that others arise from chemical sources; that bacilli form the basis of many others; and who, acknowledging that the highest aim of the physician is the cure of the sick, avails himself of every known means that the science of this latter end of the nineteenth century offers for this purpose, and uses them, if in his judgment they are necessary, for the welfare of his patient. Shall a man, suffering from the excruciating pain of urinary calculus, or the exhaustion of Bright's disease; or a woman dying in the agonies of advanced cancer, or sinking with the hectic and sweats of prolonged phthisis, be deprived of any or all the means of *palliation*, because the medical attendant chances to be a homeopathic physician? The diseases are incurable under any treatment; the finger of death is already pointing to the inevitable beyond, as if mocking the vaunted power of the medical profession, while the patient cries aloud for relief; shall the physician bend all his efforts to the relief of such sufferings as these, irrespective of creed, or shall he outrage humanity and prostitute the very essence of his calling—if homeopathic remedies fail, which they often do in such cases—by allowing such sufferings to go on unchecked until death closes the scene? Yet the opponents of homeopathy would persuade the people that, because in the treatment of disease homeopathic therapeutics are adopted, those adjuvants which belong alike to the entire medical profession cannot be tolerated in conjunction therewith; this cannot be allowed. It will not do for these men to endeavor to thrust us backward into the medical darkness of half a century ago. It will not do for them to let down the veil which the science of the last few years has lifted, and to endeavor to obstruct our view of the magnificent prospect which the instruments of precision and the advancements in physical science have revealed to our eyes. It will not do for them to endeavor to persuade the public that the homeopathist has no part or lot in the recent mighty revelations in medical science, and that his practice consists in nothing but a dogma enunciated by Hahnemann a century ago and in infinitesimal doses of drugs, that his treatment is little else than the box and book method of domestic medicine, and that the microscope, the ophthalmoscope, the laryngoscope, the electrical machine, together with the revelations in chemistry, neurology, and pathology belong only to the one old fashioned school. Why, gentlemen, by our indefensible right as physicians we claim *them all*, that is, all that are good of them, and what is more to the point, as you know, the use of all these instruments and their practical applications are fully taught in this institution. As a proof of our high estimation of these studies I may say, without boastfulness, that we give more time to their consideration than any other medical college in this city, and require examinations thereon. You who have just visited our laboratories can bear witness of this fact. Any further proof regarding these statements can readily be found by referring to our printed curriculum; it is open for inspection and demands comparison with any other medical college, and I am very willing to leave the result of such comparison to any unbiased medical scholar in this country for decision.

I have heard it said from time to time, and reiterated in high places to our discredit, that the homeopathists have done no original work in medicine, and the challenge has been given for the production of any such labor on our part. Before proceeding definitely to answer this question, it may be stated as an absolute fact that about one-half of the so-called "original work" of one century is declared absolutely worthless in the next. A perusal or reference to the medical periodicals will abundantly confirm this statement. Wonderful revelations proclaimed with much *aplomb* and confidence, as destined to exert the greatest influence upon the medicine of the century, in a very few years are relegated to the vast lumber room of the medical curiosity shop.

This is a well known and acknowledged fact. In the annual address in medicine delivered at Yale University by H. C. Wood, M.D., LL.D., Professor in the University of Pennsylvania,* the whole tenor of which is openly avowed to be an attack upon homeopathy, the learned gentleman from Philadelphia thus inadvertently discourseth on the practice of the old school medicine in the last century: "The *regular medical* practice of the day by its violence not rarely aided in causing the fatal result." . . . And again allowing his imaginative faculties full sway, he exclaimeth: "The doctor of to-day is scarcely more like the doctor of a hundred years ago than was our Darwinian forefather, blushing with shame at the sight of his first tailless offspring, like a Caucasian dandy." This lecture was delivered but a few months ago, and coming from high authority in the old school, will show you exactly how its members understand the mutability of their practice. This ever-changing therapeutics, the ever, varying disagreement between discovery and result, is so well understood by the people that proverbs are written upon it; plays ridicule it; poems satirize it; and people laugh at it. What one man calls original work, his brother of the same century is apt to proclaim as arrant nonsense, and not only erroneous, but worthless.

If one declare that he the truth descries,
The other flatly tells you that he lies;
If one announceth that a new bacillus
Will breed a pestilence and surely kill us,
The other, laughing, says: "This mundane sphere
Minus the microbe soon would disappear."
If one proclaim malaria to be
The certain cause of each infirmity,
The other proves diseases to be fewer
'Mongst those who daily labor in the sewer;
The work of one so contradicts the other,
'Tis hard, indeed, to know what they discover.

There is indeed no truer indication of the absolute uncertainty of the methods of practice now in vogue among the physicians of this century than the avidity with which this so-called "original work" is gormandized and thrust with extravagant laudations upon the public and the profession. A supposed new bacillus produced by a new culture, with a new method of propagation and a new "feeler" bigger than the last; a new chemical compound with a dignified but unpronounceable name; a newly shaped cell with more violent amœboid proclivities than its fellows; a new classification of tumors, which at last may embrace the cystic; a new theory of inflammation with a novel method of retrograde metamorphosis; a new antiseptic, the olfaction of which annihilates the entire race of germs, the discovery of any or all of which may be the result of "original work," will turn the professional head to such a stage of vertigo that older and better things are blurred and disfigured in contemplation, and the bright light of glorious and established truth becomes darkness and mist. I do not, however, wish to infer that the cultivation of useful experiments in all departments of science ought not to be encouraged, for without it medicine would be likely to halt in the race of progress; but I do mean to affirm that an immense amount of rubbish is, from time to time, thrust upon the profession, which must be sifted carefully before the pearls of thought and truth which will endure can be found; and to say in addition that the sentimental medicine which often immediately and without due consideration adopts all this, I must say often laborious work, merely because it is "*original*," will surely be knocked out of the arena of practical medicine by the fist of the slugger Time, especially if backed by a trained experience. For real original work in medicine, for work that has done and will do the greatest good to suffering humanity, for work that has stood and will stand the test of time; for work which demands more self-sacrifice than any with which I am acquainted; for work which in its completion inflicts upon the investigator actual distress and suffering, there is none that can compare with the original systematic proving of drugs as commenced by Hahnemann and continued by his followers to the present time. I claim that the actual original provings of such medicines as aconite, arsenic, belladonna, nux vomica, corrosive sublimate and hosts of others, found among our polychrests, are of more actual service to the human race than any other original work done in medicine within this century. It is one thing to enter a laboratory, and with care, patience, and perseverance prepare and classify pathological specimens obtained from brother practitioners; to look into the physiological performance of the organs of the body as illus-

* An address, delivered at the inaugural exercises of the New York Homeopathic Medical College and Hospital, January 7, 1890.

† The Craft of Surgery, page 5. Cassell & Company, London, 1886.

‡ The works of Jonathan Swift. Henry G. Bohn, York Street, London, 1853.

* Conferences upon Homeopathy, by Dr. Michael Granier. London, Leath & Ross, 1859; page 126.

* The *New Englander and Yale Review*, August, 1889, page 118. "The Medical Profession, the Medical Sects and the Law," by H. C. Wood, M.D., LL.D.

trated upon dogs; to test the action of certain poisonous drugs upon cats; to inject hydrophobic virus into rabbits; and it is quite another to daily, nay sometimes hourly, put into one's own stomach doses of poisonous drugs; to suffer the pains and inconveniences occasioned thereby; to note down every abnormal manifestation of the drug produced on one's own body, and for days and nights together carry out a prolonged systematic self-abnegation for the sake of science and the suffering human beings yet to come. This is indeed original work which demands our highest appreciation and belongs exclusively to the homeopathic school.

What is the discovery and production of such a chemical compound as antipyrine, compared to the proving of aconitum napellus? Which will do the most good to the sick? What is the sphere of action of sulfonal, when compared to that of belladonna? What is the discovery and culture of ten thousand bacilli to the correct knowledge *of the uses* of veratrum, bryonia or pulsatilla? The questions need no answer. Generations yet to come, when a new race of germs have fattened upon the old antiseptics and when new nests of alveoli will be discovered in every nucleolus as revealed by lights and lenses yet unknown, will answer this question with grateful acknowledgment.

It has also been said—and the dictum comes from high authority and has been employed against our school by those who desire to see its downfall—that after a physician has declared himself "homeopathic," he must be entirely restricted in his practice to that method of treatment; that if he finds himself unable to relieve his patient by such means, it is his duty to explain to the sick man or woman his reasons for availing himself of other methods of cure, and that the patient has a decided right when he sends for a homeopathic physician to know when other treatment than the homeopathic is to be adopted. By a similar process of reasoning it may be argued that if a patient sends for an allopathic physician, he (the patient) must be notified if other than old school therapeutics is employed. Now, ladies and gentlemen, if this method could be rigidly enforced (which of course it never can), and the records of such changes of treatment accurately kept, I am disposed to believe that about three-quarters of all treatment would be found not only to be homeopathic in principle, but in dosage, the infinitesimal granule largely preponderating over the nauseating bolus. But there is another view of this matter to be considered.

I wish here distinctly to state that the recipients of the diploma of the New York Homeopathic Medical College and Hospital *must* avail themselves of all known means for the relief of their patients. They have no choice. The document is so constructed as to give them full power to do this. It distinctly states that on account of certain studies prosecuted within the precincts of this college, the fulfillment of certain obligations and the passage of certain examinations, it confers upon its students the degree of doctor of medicine, and consequently endows them with all the rights and privileges belonging to the doctorate.

The doctor who has received the honors of this college must do whatever he can for his patient irrespective of creeds. There is no objection, however, to this information being imparted should the patient desire the same, but after an experience of over thirty years in the practice of medicine, I am of opinion that the war of the "*pathies*" must be settled by the soldiers in the field, and not by communities in other walks of life. It is out of reason to suppose that outsiders are at all interested in the squabbles of the profession. It is the doctor, not the system, as a rule, that the sick man wants. The patient employs that physician whom he thinks can cure him, sends for him because he trusts him, because he believes in his honesty, his honor, and his skill. It is a notable fact that when a physician changes his views regarding the practice of medicine, the majority of his patients follow him. I can say:

> Men racked with pain care not for science,
> 'Tis then the doctor is their chief reliance.
> They care not how the micrococci breed,
> How they are cultured, upon what they feed;
> Nor if a cell be spindle shaped or round.
> They want the doctor if he can be found.
> They want not explanations of belief,
> But cry for something that will bring relief.
> That man who quickest cures them of their ills
> (Reducing to a minimum their bills),
> With nauseating drugs disgusts them least,
> Of Æsculapius is the great high priest.

Besides, such an explanation of change of methods might indeed be very distasteful to the patient, indeed in many instances it is wholly impracticable. Let me put for example a plain and by no means improbable case. Suppose a man suffering from an overdose of poisonous medicine sends in great haste for his physician, who is a homeopathist; must the doctor sit down and explain to his client, when moments mark the rapid droppings of the sands of life, that in this instance it will be absolutely necessary to abjure the homeopathic system because it is not at all applicable, that he (the doctor) though an absolute sectarian so far as therapeutics is concerned, is a scientific physician for all that; that he understands *pharmacology* and must write a compatible prescription for an emetic; that he understands *materia medica* and can select the most appropriate drug for the purpose; that he is acquainted with *toxicology* and knows the antidote to the poisonous drug; that he is conversant with *chemistry*, and can put into the stomach the substances which will make the least injurious antidotal compound to the mucous surfaces; that his knowledge of *pathology* informs him as to the effects likely to ensue from the remote action of the poison, and that he must select the most appropriate means for the prevention of such disastrous results; that his familiarity with *anatomy* will render the introduction of the stomach tube easy and effectual—must all these things and many more regarding changes and methods of treatment be entered upon; or must the doctor immediately vomit his patient with a powerful emetic; administer the antidote to the poison, introduce the pump into the stomach, and pump away with all his might and save the threatened life? The *talk* may come after if it be necessary or deemed expedient.

There are certain conditions of disease in which the patient cannot be reasoned with, and is not able to form a correct judgment as to what may be the best method of treatment to be adopted in his case, the entire management of which should be left to the judgment of the doctor. If he be an honest and upright man, he must recognize that first over all comes human suffering, appealing to human skill, and second a complete loyalty to the system of therapeutics in which he is a believer.

I have thus far, ladies and gentlemen, endeavored to give you, as especially appropriate to these exercises, a fair insight into the present status of our school, and with as much deference and respect as the subject affords to answer the objections and explain the misconceptions which are at present prevalent in this community regarding homeopathy.

I desire now to say one word upon what I consider the greatest medical misfortune of this century, and that is the intolerance exhibited by the majority of the old school men, regarding freedom of thought and liberty of expression in the consideration of doubtful points in the science of medicine; points which ought to be open for free and friendly controversy and fair judgment, and which every man after listening to argument must consider for himself and settle according to the dictates of his own conscience.

The medical profession of this decade is in better condition to become united than at any previous era. In the olden time, when the doctors were groping in the dark to explain morbific manifestations, whether subjective or objective, when the *tolle causam* of Galen was yet re-echoing through the arches of the Æsculapian temple, when the upholders of the spiritual essence of disease were waging war upon their materialistic brothers, when either to the excess or deficiency of the humors (so called) of the body were attributed all manner of Protean diseases, when chemical combinations produced by some mysterious processes were supposed to be at the bottom of all human ailments, when mechanics was even lugged into the controversy to answer still the Galenic cry; and when one hypothesis followed rapidly upon another and diverse experiences rendered contention inevitable, any attempt at unity was indeed impossible. But now, when the mightiest and subtlest of nature's forces are held in the hand of the physician to do his bidding in the intricacies of the dark cavities of the human body, and he can watch the inception and progress of disease, much that was vague and uncertain has been definitely fixed, and the set sciences, if I may use the expression, admit of no further argument. Everything tends toward an universal brotherhood. The one single point that divides the schools to-day is the doubtful one of therapeutics, and this division is occasioned entirely and altogether by the autocratic action of the old school men, and the traditional laws of an effete ethics. There has been, it is true, among certain of the high and liberal minded, an effort at combination lately inaugurated. It is affirmed that the time has come when all prefixes as denoting systems should be done away with. That the term "physician" or "surgeon" should be all-sufficient to designate the calling of him who devotes his life to the cure of the sick or the relief of suffering. Such a condition is indeed to be desired, and can readily be accomplished, sectarianism dropped and unity established; but only in one way can this be done, viz., by the free admission of the fact by all parties (*both schools*) that every man has the right, provided he be properly educated in the collateral branches of medical science, to select the means of cure that he thinks best, for each individual case; nothing is more simple, nothing could be more effectual.

The homeopathists have never stood in the way of this much to be desired unity, and have never opposed any fair means toward its accomplishment. But, while ridicule and innuendo, if not actual abuse, are still showered upon them; when as yet no real particle of good, even if covertly acknowledged, is not openly expressed; when strained opportunities are seized to throw Hahnemann's law and those who believe in it into discredit, the upright, honorable, and self-respecting members of the new school cannot believe in the genuineness of any pacific overtures, and must remain suspiciously aloof from proposals for amalgamation unless backed by something more than "*Vox et præterea nihil.*" To those not interested in medical matters it may not be generally known that should a graduate of this college desire to investigate old school therapeutics, his three years' course of medical instruction in this institution would count for nothing in the eyes of the majority of allopathic professors. It may not be generally known that students have been prohibited from matriculating in allopathic colleges in this city, simply because they are known to have homeopathic preceptors. It may not be generally known that the membership of the allopathic medical societies cannot be obtained without the withdrawal from every journal, college, or hospital that is called homeopathic,* and that, moreover, lamentable as it may appear, the leading allopathists of to-day, notwithstanding the liberality of spirit in matters of science which the discoveries of this century ought to have revealed to them, take especial pains to stigmatize homeopathy in a most uncalled for and inexcusable manner. For instance, in a pictorial article on snakes which appeared in the *Century* for August, 1889, S. Weir Mitchell, M.D., thus writes: "Charas' belief in the value of the volatile salt of the ashes of calcined vipers as a remedy for viper bites is an instructive exhibition of a form of *medical idiocy not without modern illustration.*" 'Tis the straw that shows the course of the wind. What could be the object of such an illusion in such a place? What good was supposed to be effected thereby? It was merely the bursting of a gall duct from over-distention with acrid bile.

In the *Medical News* of October 18, 1889, a physician honestly states his convictions, which are in accordance with the progress of the century, and enters a protest regarding the dogmatism of his brothers, but in the same periodical, nay, the very next article, there appears a reply by S. Solis-Cohen, M.D., in which the old, old arguments are adduced—statistics of years long since passed are trumped up, Hahnemannism and homeopathy are used as synonymous, it is plainly stated that homeopathy "forbids diagnosis and condemns the attempt to direct treatment to definite ends," and finishes by attributing to the members of our school the most cowardly and abominable conduct.

In the very same number of that periodical, the leader gives the weight of its editorial power against the homeopathists, the language of which reminds us of the rancor of the elder Whately in the *Lancet* thirty years ago. One stands aghast and inadvertently asks the questions, Are these the outpourings of the cultivated minds of an ancient and honorable profession, widened and liberalized by scientific knowledge, or are they the bitter fruits of that contagious and epidemic bigotry which has characterized the allopathists since Hippocrates was a boy, and through the pervading, pernicious influence of which they assailed Paré, slanged Harvey, and damned Jenner and a host of others whom they have since immortalized?

Even to-day, the old school, clinging with dogmatic pertinacity to the tradition of its ancestry, and in spite of all the light that this century has showered upon its head, with the fact that what is declared absolutely impossible to-day may be found easy of accomplishment to-morrow legibly written in every department of science, when "human reason is now forced to admit that as to the origin of phenomena, as to anything outside of them, both physics and metaphysics are doomed to such absolute nescience that they cannot pronounce a single proposition to be possible or impossible, probable or improbable,"* with all these revelations made clear by the effulgence that surrounds the medicine of this century, this ancient, regular scientific and "progressive" school shuts its eyelids, and from the Stymphalian bog of its traditional dogmatism would lay down the law regarding the method of therapeutics to be employed by the whole world, prosecute all members of the profession who dare to defy its mandamus, cut them off from all places of honor or emolument, force them for their own safety and improvement (if they would not stagnate in this age of momentum) to become *sectarian*, and then, having thoroughly accomplished its purpose, thrusts forward that very *sectarianism* which it has not only born and nourished, but as you see from the few quotations I have read you, it is strenuously endeavoring to perpetuate, as a bar to the union of the medical profession! Looking the whole matter squarely in the face, it is the most ludicrous piece of incongruity yet perpetrated in this century. In nature it often happens that the agents which generate decomposition by prolonged and intensified action destroy it altogether, as in heat and moisture. In science we know that the so-called chemical disinfectants increase oxidation or remove it entirely, and so it is by no means an uncommon occurrence in the progress of human affairs, that over-strenuous efforts toward the accomplishment of certain objects in some unforeseen manner defeat the ends they were designed to subserve, and so that very sectarianism into which persecution and bitterness of spirit drove the earlier homeopathists, and which was intended for their entire annihilation, has done much for the preservation of the system for which they suffered. Sectarianism, by its enthusiasm, has proclaimed it, by its energy has advanced it, by its bravery has protected it, and by its self-sacrifice has ennobled it, and to-day, *having accomplished its object*, holds it modified but triumphant in the hollow of the hand.

And now I am free to say, and I think I voice the feelings of many others, that I for one am willing to drop all titles, to use all influence to merge all sects into a common brotherhood, not only for the good of humanity, but for the comfort and mutual self-respect of all concerned, provided the old school, being honest in its desires, will remove the restrictions it appears to think it has the power to enforce over the prescribing rights of medical practitioners, and allows me, after being thoroughly satisfied of other educational qualifications and not otherwise, to pursue my own course in therapeutics.

Surely this is fair; surely this is right; surely this is honorable. Scorn, ridicule, contempt, innuendo, and abuse must cease on the part of the allopathists; recognition of power, goodness, honor, and justice when it *exists* must be freely acknowledged on all sides by both schools; for to lament the decadence of the friendship of a man whom one continually, persistently, and profoundly insults on all occasions that are offered, and on *some that are made for the purpose*, is so palpable an hypocrisy that nothing can extenuate it.

But the time is coming, we hope, when the unity of the profession of medicine will be accomplished by that great process of evolution which pervades all nature. There is a certain intellectual development now taking place throughout the world that cannot be overlooked; opposing elements in religion and in science have been made to harmonize.

In religion agnosticism is found to be not incompatible with theism, and the supposed fatal blow directed against the very element of all religious faith is disarmed by the presence of "a great first cause;" the *Dubito* of the materialist bows before *Credo* of the Christian.

In medical science the recognition of the great power of the *vis medicatrix naturæ* in restoring organic equilibration; the reacknowledgment of the dynamic nature of disease, so strenuously insisted upon by Hahnemann; the acceptance of the doctrines of evolution and dissolution as applied to pathology, and the reception of the fact that life itself is "a moving equilibrium," are the seeds now sown broadcast in the mental fields of the profession, which must yield an abundant harvest, must dissolve the older methods of therapeutics, render a knowledge of the etiology of disease a necessity to every conscientious practitioner, and allow the widest liberality in threapeutics, not only regarding the character of the drug administered, but of the dose to be exhibited.

Moreover, ladies and gentlemen, mankind is not so bad as it often seems; every single man has good in him, and the inherent quality of good would *not be good* unless it were capable of educational development. Couple with this another indisputable fact, that surrounding environments of education, hereditary descent, climate, tradition, example, and a hundred other

* Here are the actual questions asked by the Medical Society of the County of New York to one of the members of the staff of the Homeopathic Hospital on Ward's Island who desired membership of the Allopathic Society:

1. Have you resigned from all homeopathic medical organizations?
2. Do you propose from this date (September 27, 1884) forward to practice medicine without sectarian designation?
3. Are you willing to be governed professionally by the by-laws and regulations of the Medical Society of the County of New York?
4. Are you an editor or an associate editor, or in any way connected with a homeopathic medical journal?

* "Agnostic Faith." London. W. Redgway, 1889, page 56.

circumstances tend to the formation of varied temperaments and constitutions, the very versatility of which must ever breed differences of opinion in regard to points unsettled by rigid science.

Considering then these two propositions in the abstract, it seems to me to be a logical sequence that if the medical profession would seek to cultivate the good—and it is as great as it is mighty—which exists within its ranks, that this expanding goodness, appreciating the fact that differences of opinion must always exist among the profession, will tolerate and understand this inevitable diversity. This done, unity will follow in due course.

It is not so much the higher status of medical education, nor is it by the enactments of laws by the governing bodies of the State that will effect the unity of medical men, because, in the first place, medical acquirements alone, together with the constant application of the mind to medical literature, while they produce the medical scholar, can also evolve a medical bigot.

And in the second place, because legislative enactments, while they may regulate in a measure the qualifications of the physician and prevent the spread of quackery, are likely to become partisan on account of the involved political influence, thus leading to discussion, and the dissatisfaction of the defeated party. Combined with these factors the highest and best qualities of man's nature are demanded. The actual love of humanity, for humanity's self, which bears and forbears, that looks to the great end to be accomplished in the life work of the physician, and finds for its motto, "*In certis unitas, in dubiis libertas, in omnibus caritas.*"

PAINTS OR ROUGES.

ACCORDING to Mierzinsky, these preparations are not only in demand for toilet purposes, but are also indispensable to the actor and actress.

They may be divided into (*a*) fatty powders, (*b*) fatty paints in sticks, (*c*) palette paints, and (*d*) liquid paints.

For the preparation of all these the following are necessary: Pure white French chalk, thoroughly washed with dilute acetic acid, carbonate of magnesia, oxy-chloride of bismuth, sub-nitrate of bismuth, chalk, lead, zinc, and barium whites, and coloring matters.

FATTY POWDERS.

These contain as basis pure white French chalk; in order to temper the character of this, it is mixed with magnesia, chalk, zinc, or lead white or bismuth. The finest paint is furnished by bismuth white, only it possesses the disadvantage in a higher degree than even lead white of turning brown in a sulphureted atmosphere. Zinc white has not the same drawback, but it fails in luster and is not so pure a white. The paint is colored red with carmine, pink with eosin, and flesh color with a mixture of eosin and aniline orange. Mostly the red paint is in demand, and it must be matched with the complexion. It should be kept both dark and pale. The following mixtures should be kept prepared:

90 parts French chalk with 90 parts carmine.
110 " " " " 30 " "
125 " " " " 25 " "

These can be rubbed up with a few drops of fatty oil and perfumed as desired. Coal tar colors must be dissolved before admixture, but the operator must proceed with great care, as the colors are greedily taken up by the French chalk.

FATTY PAINTS IN STICKS.

These have wax, cacao butter, benzoated oil, or suet, with French chalk as bases. Sometimes a mixture of these may be used, sometimes benzoated suet with cacao butter, sometimes cacao butter alone.

The following formulæ give good results:

I. Take of—

White wax	2 parts.
Olive oil, or almond oil, or suet	3 "
French chalk	1 "
Zinc oxide	1 "

Mix.

II. Take of—

White wax	2 parts.
Oil or benzoated suet	2 "
Bismuth white	5 "

Mix.

These are colored red, if desired, with an ammoniacal carmine solution. The proportion of one part of carmine to forty parts of base is most approved, and the best method of procedure is to dissolve one part of carmine in four-eighths part of strongest ammonia, to mix this solution with six parts of French chalk, and to stir until the ammonia has evaporated and the mixture become dry. This colored chalk is then mixed with a basis made from 13½ parts of wax and 30 of any fixed oil.

PALETTE PAINTS

contain the same materials as the powders, rubbed with thin mucilage to a paste, and fixed on plates of porcelain with a very thick mucilage. These paints must be intensely colored. Cinnabar is frequently used for these paints as under:

Take of—

French chalk	190 grammes.
Best cinnabar	30 "

Rub together with six drops of almond oil, and then with a few drops of tragacanth mucilage.

LIQUID PAINTS.

In these the whites or colors are suspended. The following are the formulæ of such preparations, both white and colored:

Eau de Lys.

Take of—

Zinc white	10 parts.
French chalk	10 "
Glycerine	20 "
Rose water	1,000 "

Mix.

Lait d'Iris.

Take of—

Bismuth white	10 parts.
Water	120 "

Mix. The water is perfumed with essential oil of orris.

Take of—

Eosin	4 parts.
Distilled water	80 "
Glycerine	20 "
Eau de cologne	300 "
Spirit (free from fusel oil)	400 "

Dissolve. Allow to stand and filter. According to desire, the proportion of eosin may be increased, or diminished, or modified with aniline orange.

Take of—

Finest carmine	20 parts.
Lead white	30 "
French chalk	60 "
Tincture of benzoin (simple)	5 "
Eau de cologne	50 "
Rose water	250 "

Mix.

Take of—

Carmine	4 parts.
Strongest ammonia	4 "
Rose water	500 "
Essence of rose	15 "

This liquid is principally used to give the lips the beautiful cherry red color which is so much admired.—*Br. and Col. Dr.*

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